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CONTENTS

EDITORIAL:
Predetermining Alternator Characteristics . . . 877
High-Efficiency Electric Lamps . . . 877
Electricity in Medicine . . . 879
Possible Prediction of Earthquakes . . . 879
Fuel, Water and Gas Analysis for Steam Users, by John B. C. Kershaw (Concluded) . . . 880
Tantalite in Australia . . . 883
The "Electrician," Electrical Trades Directory and Handbook . . . 883
Recent Storage Battery Improvements, by Sherard Cowper-Coles . . . 884
Electric Power in the Transvaal . . . 888
Armature Reaction in Polyphase Alternators, by L. A. Herdt . . . 889
Athletic Sports for Operators, by J. E. Peavey . . . 893
Electrical Equipment of the Erie Railroad Shops at Hornell (Hornellsville), N. Y . . . 894
The Chicago Electrical Trades Exposition . . . 898
Non-Resident Lectures at the University of Minnesota . . . 898
Magnetograph Records of Earthquakes, with Special Reference to the San Francisco Earthquake . . . 901
BOOK REVIEWS . . . 901
Electrical Trades Association of Chicago . . . 901
REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE . . . 902
METHODS OF GETTING NEW BUSINESS—"Organization and Conduct of a New-Business Department Suitable for Central Stations in Cities of 50,000 Population and Under," by James L. Wiltse . . . 904
INDUSTRIAL SECTION:
A New Splice Protector . . . 906
The Apple Ignition System for 1907 . . . 906
Diesel Engines for Interurban Railway Service, by Norman McCarty . . . 907
Blue-Print Washing Machine . . . 908
Fireproof Insulated Magnet Wire, by W. H. Easton . . . 908
Two Thousand Six Hundred Dollars in Prizes for an Electrical Solicitor's Handbook . . . 909
Automatic Electric Motor-Driven Pumping Plant . . . 909
To Harness Victoria Falls . . . 909
CURRENT ELECTRICAL NEWS . . . 910
RECORD OF ELECTRICAL PATENTS . . . 915

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PREDETERMINING ALTERNATOR CHARACTERISTICS.

In spite of the assertion made by electrical engineers, particularly designing engineers, that they are able to predict most accurately the performance of the machines built according to their designs, there is one machine which has given a great deal of trouble and has baffled many. The alternating-current generator, while in its construction one of the simplest electrical machines, has not yielded readily to analytical and graphical analyses. The machine can not be called erratic, because one such machine always behaves in the same way, and, having built one, it is always easy to say how another, built exactly like it, will behave. But if the design be changed either in size or in type the performance of the older machine does not give a ready means of predetermining how the new one will behave. This problem has been attacked by many, some with a good degree of success, although the methods of procedure differ considerably. While it may not be possible now to say beforehand just exactly what will be the result, there is no difficulty in predicting it with sufficient accuracy for all practical purposes.

Although, from the viewpoint of the designing engineer, matters are in a fairly satisfactory state, new methods of attacking the problem are of interest and of value, if they are simpler or give better results. On another page of this issue a solution is offered by Mr. L. A. Herdt, which, while not entirely new, since it was proposed by him several years ago, is nevertheless worthy of careful study. In the author's hands it has given results agreeing remarkably well with those obtained from direct tests.

HIGH-EFFICIENCY ELECTRIC LAMPS.

Two exceptionally interesting papers were read at the meeting of the American Institute of Electrical Engineers which took place in New York city on Friday evening, November 23. One of these deals particularly with the arc type of light and was presented by Dr. C. P. Steinmetz in his usual clear and convincing manner. The other, not less interesting to users as well as to the lighting companies and lamp manufacturers, was by Dr. Clayton H. Sharp, and gave much more information than has hitherto been available respecting one of the newer types of metallic-filament incandescent lamp—the tungsten lamp, which seems at the present time to be the most efficient of all the newer lamps. A report of this meeting, with the discussion of the papers, will be found on another page of this issue.

Dr. Steinmetz's paper is valuable from the thorough way

in which the subject is treated; in fact, as indicated by the title, it is an erudite study of the transformation of electric power into light, and is particularly valuable at this time when so much interest and energy are being shown in the improvement of electric lamps. That there is ample room for such improvement is well known; indeed, were it not true that these lamps compare so favorably with other types of illuminants of practical value to man, we should be ashamed of an efficiency of transformation of less than one per cent from heat energy into luminous radiations. Any improvement is therefore much to be desired, provided that it does not involve disadvantages which more than counterbalance it; and our present knowledge shows that it is possible to improve the efficiency as compared with our present commercial types of lamp two or three times, or perhaps more. Such improvements, if put into practice, would certainly profoundly affect the electric lighting industry. Just how can not be surely predicted. A sudden change to the new lamps would first decrease the station output. This would be immediately followed by a large increase in the use of electric lights which would probably in a short time carry the station load much beyond what it had been before the change; and a more general use of electric lamps would also affect the station load-factor, probably improving it, since, as a general rule, the larger the number of consumers the less variable the load. These revolutionary improvements in electric lighting would still leave the lamps in an unenviable position as compared with other electrical machinery, but there seems to be no hope of securing for the lamps an efficiency which, for motors or transformers, would be considered respectable, by working along any of the lines which are now being followed.

This matter of luminous efficiency is an exceedingly complicated one, for what we desire is a physiological effect, while what we measure is a physical one. Thus, to secure the best performance it is necessary not only to produce a considerable proportion of the radiations within the visible range, but, of this proportion, a good deal must lie in that part of the spectrum to which the eye is most sensitive—that is to say, the green and yellow. In other words, a lamp may be highly efficient, comparatively speaking, when subjected to physical tests, because of the proportion of its radiations lying within the visible spectrum; yet, since the greater part of this may be in the red or in the violet, the result may be less satisfactory physiologically than that produced by a lamp which, while giving off a lower percentage of its radiations as compared with the former lamp within the visible spectrum, still gives off a good proportion of green and yellow. Stated in other words, a given amount of radiant energy is less effective in the form of red rays than in the form of yellow. Moreover, as in everything else, high efficiency is not the only desirable feature. The color of the light is just as important, and the convenience of the lamp and its lack of undesirable features are points of sufficient weight to turn the balance one way or the other. As long as sunlight is taken as the standard the most desirable light is one containing rays from the red and blue ends of the spectrum, as well as the yellow, even though their presence lower the efficiency of the lamp when measured physiologically.

The latter part of Dr. Steinmetz's paper dealt particularly with lamps of the arc type. It is shown that there are two ways of securing light—by radiation from incandescent electrodes when the arc itself is non-luminous, or by radiation from a luminous arc. There are two ways of rendering the arc luminous. One is that employed in the so-called flame arcs, in which the incandescent material is supplied by vapors set free from the positive electrode by heat, and the other that in which the luminous vapor is produced directly by the electric current, since it forms a true arc and provides the conducting path. This is the type of arc given by the magnetite lamp, and it is thought by Dr. Steinmetz to be the case in which there is the most direct production of light from electricity; in fact, the efficiency of this type of arc is, to a considerable extent, independent of the electrode temperature. At the present time the only suitable materials for this arc are the metals of the iron group, and, as used, they are in the form of oxides so as to avoid the deleterious effects of oxidation at high temperatures. The best results are obtained by using a mixture of iron and titanium oxides, the former supplying, to a large extent, the conducting vapor; while the latter increases the efficiency of the arc as a light-producer.

While Dr. Sharp's paper deals in a general way with all the newer types of high-efficiency lamps, the most interesting part is that relating to the tungsten lamp. This is one of the latest types brought forward, and, at the same time, from the results presented in the paper, it would seem to offer much promise of success. Tungsten is too refractory to be worked as other metals, and its conversion into filament form is brought about in another way, which does not differ so greatly from the method of producing carbon filaments. A paste of the powdered metal is expressed through dies into filament form, and is then dried and the binding material removed by heating or chemical treatment. There are several ways of securing the metal in the necessary finely divided state, but present information is not sufficient to enable a comparison to be drawn. Dr. Sharp does, however, compare the tungsten filament with the tantalum, considerably to the advantage of the former. Tantalum, unfortunately, for some unknown reason, becomes striated. The effect is more pronounced in alternating currents of high frequency, rendering the lamp, as at present manufactured, unsuitable for such systems. This defect has not been found in the tungsten lamp. And the latter gives a higher efficiency as measured in watts per candle-power, and a longer life.

The tungsten lamp shares the disadvantage of the other metallic-filament lamps that, due to the high conductivity, it is only made in large units and for low voltages—that is to say, for not less than twenty-five candle-power, nor more than 110 volts. The former feature is a disadvantage from the point of view of the illuminating engineer, and the latter from that of the central station. It possesses, however, the ability of repairing itself after the filament is broken. This repair, it seems, is not as satisfactory as is that of the tantalum lamp, because,

due to the infusibility of the metal, the weld is not so perfect, but it is sufficient to enable the lamp to go on burning. Dr. Sharp raises the question whether, in obtaining figures showing the useful life of these lamps, this first break should be considered the stopping point, or whether the lamp should be allowed to mend itself and the test continue. This is a point to be considered when a comparison is being made with carbon lamps, but when determining the useful life for ordinary purposes it certainly should be taken into consideration. What one really wants to determine is the point at which it no longer pays to use the lamp, and since the first cost will be greater than that of the carbon lamps, it should be run a longer time; in fact, it would seem logical to allow the candle-power to fall to a point lower than that now accepted as the smashing point for carbon lamps, if it be found that the new lamps will last so long. The breaking of a filament and its rewelding do not lower the candle-power and efficiency—rather the reverse. Another point to be considered in this connection is the change in the distribution of the light due to the blackening of the bulb of the new lamps; but since the loss is chiefly in a horizontal direction, the proportion of light which is thrown down and thus used without reflectors is not so much affected. From the central station point of view the most significant feature of the tungsten lamp is its efficiency, which is about three times that of the carbon lamp, even in its present state. It is not probable, however, that there will be any sudden change from the old to the new, and if no unexpected developments take place there will be a transition period from the old to the new which will enable all to accommodate themselves to the new conditions.

ELECTRICITY IN MEDICINE.

Probably every science suffers from those human leeches who seize upon every advance and discovery to aid them in bleeding the credulous public, and when a science is closely identified with industries which are working mightily to uplift the world, the opportunity for such charlatans seems to be greatly multiplied. Electrical science and arts seem to have suffered more than their fair share from such persons, although electrical energy is so widely used in so many ways as a means to an end that the opportunities for such impositions have probably been unusually great. And when, in addition, the really surprising discoveries that are associated with electricity, in the public mind, at least, are recalled, it is seen that the chances offered for deceiving the ignorant have been exceptional.

That many have availed themselves of this opportunity can not be denied, and it is therefore comforting to hear such sensible remarks upon the use of electricity for treating human ailments as were made by Dr. John V. Shoemaker in a recent paper before the Pennsylvania State Medical College, at Bedford Springs, Pa. A brief abstract of this paper appeared in the ELECTRICAL REVIEW for November 24, but the remarks referred to will bear repetition: "Electricity in most cases is to be regarded only as an adjunct to other treatment. While giving the special electric application we should also give appropriate remedies to act upon the glands of excretion and secretion. . . . Massage, exercise in the fresh air and proper diet and regulation of habits of the individual—all these are accessory agents and should be conjoined with the electrical treatment if we wish to obtain the best results. Such, indeed, is the intelligent medical use of this agent in the hands of the qualified physician. Without such therapeutic accessories electricity, like massage, is very restricted in its usefulness and tends toward charlatanism."

One hears so much speculation, by those with little knowledge, about electricity and its relation to life that it is pleasing to find it put in its proper place for medical purposes. Here, as in all other uses, it is a means to an end, an agent for bringing about certain results; and to be successful it must be used in its proper place and in harmony with other agencies.

POSSIBLE PREDICTION OF EARTHQUAKES.

When the disastrous earthquake occurred last summer at Valparaiso, a paragraph went the rounds of the daily newspapers which stated that a warning had been issued to the city the day before. No explanation of this paragraph has been given, and in the absence of volcanic action preliminary to the quake, a good deal of interest was aroused by the reported prediction. It was probably merely a mistake, very likely due to some statement given out by the local observatory.

In the September issue of *Terrestrial Magnetism and Atmospheric Electricity* there is an interesting paper by Dr. L. A. Bauer, on "Magnetograph Records of Earthquakes, with Special Reference to the San Francisco Earthquake." This study was suggested by the behavior of certain magnetic observatories located throughout the world, but principally in this country. It was found, by comparing these records, that the magnetograph was frequently disturbed by earthquakes, but in a somewhat erratic way. Records were secured at unexpected points, while there was nothing to show that a disturbance had taken place at other observatories where a record might be expected. This has suggested the idea to Dr. Bauer that there is a slight possibility of some magnetic disturbances brought about by the earthquake, and if this were found to be true it might also be found that the magnetic disturbances would occur before that due to the trembling of the earth, because the magnetic waves would travel more rapidly than the ground waves. In other words, a disturbance of the magnetograph might serve to predict, by a short time, a coming earthquake wave.

A comparative examination of the available records does not agree with this idea, although the magnetograph records seem to involve some disturbance not recorded by the seismograph, so that there is still a possibility that some magnetic effect is produced and that the record of the magnetograph is not simply due to the motion of its supports. The subject is worthy of further study. Even though the prospect of being able to predict an earthquake far enough ahead to make the prediction of practical value is slight, still it has not been proved impossible; and, moreover, the scientific side of the question is of very great interest.

FUEL, WATER AND GAS ANALYSIS FOR STEAM USERS.[1]

BY JOHN B. C. KERSHAW.

(Concluded.)

XII—The Practical Application of the Gas-Test Results.

1. Calculation of the Total Heat Losses Due to the Volume and Specific Heat of the Exit Gases—In order to be able to calculate the heat lost daily with the waste gases from any boiler plant it is necessary to obtain figures showing the mean temperature, and the mean CO_2 and CO contents[2] of these gases for the twelve or twenty-four hours. These returns may be based either upon the average of a stated number of snap-tests, or upon the results obtained with one of the automatic recording instruments.

As already pointed out in Article xi, the automatic gas-testing apparatus only records percentages of CO_2, and where any apparatus of this kind is installed it is still necessary to make occasional tests of the gases with the modified Orsat apparatus, in order to be certain that no carbonic oxide is present in the waste gases. This precaution is all the more necessary since the tendency where automatic apparatus has been installed is to work the furnaces with too little rather than with too great an excess of air, in order to obtain carbonic acid gas averages above ten per cent. A simple calculation will show that it is better to have ten per cent CO_2 and no CO in the exit gases than fourteen per cent CO_2 and two per cent CO. This is a fact which is not sufficiently recognized by boiler engineers who have installed automatic apparatus, and trust to the records of this alone in controlling the working of their boiler plant. The modified form of Orsat apparatus described in Article x ought, therefore, to be installed in any works using over fifty tons of fuel per week. Tests of the waste gases should be made with this apparatus daily, both as a check upon the automatic recording apparatus, and as a guide to the economic working of the whole plant.

Air contains, in round numbers, twenty-one per cent by volume of oxygen and seventy-nine per cent of nitrogen. When this oxygen is employed for burning solid carbon, it yields the same volume of carbon dioxide gas. If, therefore, the whole of the oxygen of the air could be used up in burning fuel on the grates of steam-boiler furnaces, and if this fuel contained nothing beyond carbon and ash, a maximum percentage of twenty-one per cent CO_2 by volume in the waste gases would be attainable.

Two facts render this maximum impossible of attainment. In the first place all solid and liquid fuels contain hydrogen, and the oxygen likewise contained in fuel is not sufficient to combine with this hydrogen and to yield with it aqueous vapor. Therefore some portion of the oxygen of the air is required to burn the excess hydrogen contained in the fuel.

Further, under actual conditions of work, it is impossible to burn solid fuel properly with only the theoretical amount of oxygen. An excess varying from fifty per cent to 100 per cent above this theoretical amount is required to obtain perfect combustion of the fuel.

The hydrogen present varies considerably in different classes of solid fuel: in bituminous fuels it ranges, as a rule, from three to six per cent. By calculating the weight of oxygen required to burn the hydrogen present in the fuel, and by deducting from this the oxygen contained in the fuel, one obtains the oxygen required from the air. Deducting the equivalent volume of this from 20.8, we have the percentage by volume of oxygen available for combustion of the carbon. This figure for most bituminous fuels is about 19.2 per cent, and this therefore represents the maximum percentage of CO_2 which could be obtained by perfect combustion with the theoretical amount of air. Now, supposing we have an average test for the day of the waste gases of ten per cent CO_2, and an average temperature of 465 degrees Fahrenheit at the base of the chimney; how are these figures to be used to calculate the 2,304 British thermal units given in Article iv as the thermal loss under these conditions of work?

The calculation is as follows:

Ten per cent CO_2 equals an air consumption of $\frac{19.2}{10}$ or 1.92 times that theoretically necessary. As twelve pounds of air are theoretically required for the combustion of one pound of fuel, this excess of air represents 12×1.92, or twenty-three pounds of air consumed per pound of fuel, yielding twenty-four pounds of waste gases.

The specific heat of these gases may be taken as 0.240. The loss of heat with the waste gases, per pound of fuel burnt, is therefore $24 \times 0.24 \times 400$[1] $= 2{,}304$ British thermal units.

The calculation for any other percentage of CO_2 in the exit gases is similarly made, the maximum percentage of CO_2 (19.2) being used as a means for finding the excess of air represented by any given percentage of CO_2.

2. Calculation of the Heat Losses Due to Imperfect Combustion—The gases due to the imperfect combustion of fuel are carbon-monoxide, free hydrogen and certain hydrocarbons of the methane and ethylene series. Since the heat produced by the combustion of fuel is dependent upon the complete oxidation of the carbon and hydrogen to carbon dioxide gas and aqueous vapor, respectively, it is evident that incomplete oxidation must be accompanied by loss of heat, and that the amount of this loss will depend upon the volume of the unburned hydrogen, hydrocarbons and carbonic oxide gases. The following methods can be applied for calculating these losses from the results of the approximate analysis of the waste gases by the improved Orsat apparatus described in Article x; the percentage of carbon in the fuel and percentage by volume of hydrogen, carbonic oxide and carbon dioxide in the waste gases being the test figures required for the calculation.

(*a*)—*Losses Due to Carbonic Oxide*—Fuel contained eighty per cent carbon, waste gases contained two per cent carbonic oxide with eight per cent of carbon dioxide. Since carbonic oxide yields on combustion its own volume of carbon dioxide, the total volume of carbon dioxide, if the oxidation of the carbon had been complete, would have been 2 + 8, or 10 per cent. Therefore, two-tenths or one-fifth of the carbon had escaped complete oxidation. This is equivalent to $0.80 \times \frac{1}{5}$ or 0.16 pound of carbon.

Now, it has been proved by experiment that when one pound of carbon is burned to carbonic oxide it produces 4,415 British thermal units of heat, while when it is burned to carbon dioxide it produces 14,646 British thermal units (the difference between the heat produced by the union with the first atom of oxygen and that with the second atom of oxygen is believed to represent the work done in converting the solid carbon into the gaseous form.) The heat loss arising from incomplete combustion of the carbon is therefore 14,646—4,415, or 10,231 British thermal units, and the heat loss in British thermal units for the particular case under discussion is $10{,}231 \times 0.16 = 1{,}637$ British thermal units for every pound of fuel burnt. Supposing that the fuel in this case had a thermal value of 14,320 British

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[2] CO_2 is the chemical symbol for carbon dioxide and CO that for carbon-monoxide.

[1] It is assumed that the air temperature is 65 degrees Fahrenheit and that the net loss of heat in the exit gases is 465 — 65 = 400 degrees Fahrenheit.

thermal units, the heat lost by imperfect combustion of the carbon and production of two per cent of carbonic oxide in the waste gases would amount to 11.40 per cent of the total heat value of the fuel. These figures prove the great importance of testing for carbonic oxide, and the inadequacy of any system of control which ignores its possible presence in the exit gases.

The general formula for calculating the losses due to carbonic oxide is:

$$X = \frac{\text{per cent CO}}{\text{per cent } CO_2 + \text{per cent CO}} \times \frac{\text{percentage of carbon in fuel}}{100} \times 10{,}231$$

in which X represents the British thermal units lost per pound of fuel burnt.

(*b*)—*Losses Due to Hydrogen*—The older theory of combustion assumed that oxygen had a preferential attraction for hydrogen in presence of carbon, and that all the hydrogen would be burned to aqueous vapor before any of the carbon was oxidized to carbonic oxide or carbon dioxide.

The recent researches of Bone and others upon the chemistry of the combustion process have shown that this theory is incorrect, and that hydrogen can still exist in the free state in the combustible gases after the oxidation of the carbon has commenced. On the other hand, Sodeau has proved that by the use of improved methods, notable amounts of free hydrogen can be found in the exit gases from boiler plants worked with an insufficient air supply, and in the article referred to below[1] he gives the following analyses of the exit gases from a 1,000-horse-power water-tube boiler of the Express type, fired with Welsh coal.

CO_2	9.0	11.0	9.9	9.2
CO	2.15	2.8	1.65	1.3
H	0.65	0.55	0.47	0.4

These tests prove conclusively that free hydrogen may exist in the exit gases from boiler furnaces in the presence of considerable percentages of carbon dioxide, and that the older view that the hydrogen must be first completely burnt to aqueous vapor before the combustion of the carbon occurred, is incorrect. It is therefore always advisable to test for the presence of hydrogen in the exit gases from boilers worked under close supervision as regards air excess, since with the escape of one per cent of unconsumed hydrogen, considerable heat losses may arise.

The method of calculation is less simple than in the case of carbonic oxide, since in the absence of any test for the aqueous vapor, one is unable to state the loss as a proportion of the total hydrogen present in the fuel. It is therefore necessary first to calculate from the volume percentages of the gas analysis the weight of the various gases by aid of the specific gravity figures given in Article iv. Taking the first example given above by Sodeau, we have the following figures:

	Percentage by Volume.		Factor.		Equivalent by Weight.
Carbon dioxide	9.0	×	1 529	=	13.76
Carbon monoxide	2.15	×	.967	=	2.07
Hydrogen	0.65	×	.069	=	0.045
Oxygen	8.00	×	1.105	=	8.84
Nitrogen	80.20	×	.971	=	77.87
	100.00				102.585

The figure 0.045 in 102.585 of waste gases is equivalent to 0.0439 per cent hydrogen by weight.

By application of the method described in Section i of this article we find that a percentage by volume in these gases of nine per cent CO_2 and 2.15 per cent CO corresponds to an air supply of 20.52 pounds of air, and to a production of 21.52 pounds of waste gases per pound of fuel burnt. The weight of hydrogen which is escaping combustion per pound of fuel burned in the above case is therefore $\frac{0.0439 \times 21.5}{100}$ or 0.009438 pound. Now, one pound of hydrogen gas, when burned completely to H_2O, produces 62,100 British thermal units of heat, and the loss of heat in the particular case named above is therefore 0.009458 × 62,100 or 586 British thermal units, equivalent to four per cent of the total heat value of the fuel. Although the percentage of free hydrogen in the waste gases by volume may be small, it is thus seen to be of considerable importance in its effect upon the heat losses, and its presence ought always to be made the subject of special tests.

(*c*)—*Heat Losses Due to Unburned Hydrocarbon Gases*—Since the hydrocarbon gases, methane, ethylene, etc., will have been burned to carbon dioxide and aqueous vapor, respectively, in the combustion pipette described in Article x, and have been returned in the test as carbon monoxide and free hydrogen, it is unnecessary to make any separate calculations for the heat losses due to the presence of these gases. The error in the final result is negligible, for both elements exist in combination in the gaseous state in the hydrocarbon gases, and the thermal energy required to render them free is probably small. The thermal values given for the combustion of free hydrogen and of the gaseous atom of carbon in carbon monoxide are therefore applicable, and the calculations given under *a* and *b* include the losses due to the possible percentage of these hydrocarbon gases.

3. Circulation of the Heat Losses Due to Air Leakage. (*a*)—*At the Dampers*—Tests of the CO_2 present in snap samples of the exit gases drawn simultaneously from the sampling hole just within the damper (on the furnace side of it) and from the nearest sampling hole on the chimney side of it, at a distance of at least two yards, are made. If the tests differ by less than half of one per cent the air leakage may be regarded as slight.

In some cases, however, it will be found that a difference of two or more per cent exists between the tests of the two samples. The excess of air and heat loss represented by this difference is then calculated by the method given under Section i of this article. It is advisable when making use of this method to check the air leakage at the dampers, to make the test when the boiler fires are burned red, and to see that no interference with the fires occurs during the sampling operation. Both sampling tubes should be inserted an equal distance into the flues, and it is, of course, necessary to take the second sample of gas from the flue at a point where the exit gases from other boilers have not had a chance to mix with it and to change its composition.

Air leakage at dampers and through the flues of incompletely dampered-off boilers is a prolific cause of bad draught in most boiler plants, and attention to this defect is urgently needed. Since the cold air drawn into the flues in this way does not pass through the furnace of the boiler it may be argued that the heat loss is negligible. In most modern boiler plants, however, economizers or feed-water heaters are employed for extracting some portion of the heat from the waste gases; and the dilution with cold air drawn in through the dampers of the boilers diminishes greatly the efficiency of this accessory plant. The use of gas testing for discovering and checking this leakage is therefore of considerable importance.

(*b*)—*Through the Brickwork of the Boiler Setting, Economizer and Flue Walls*—The method of making the test is described under *a*. Simultaneous snap samples are drawn from different sections of the flue, and are tested for the percentage of CO_2. The gradual reduction in the percentage of CO_2 as the sampling approaches the chimney is the measure of the air leakage. The calculation of the air excess and of the heat loss

[1] *Chemical News*, February 5, 1904.

is carried out as already described in detail under Section 1 of this article. In nearly every case where special attention has been devoted to this subject, considerable air leakage through the brickwork of boilers and flues has been found; and the casting in of the rough setting of these in glazed bricks or in sheet iron has been found to result in considerable economy. It must be pointed out here that leakage through the brickwork setting of a boiler or through the economizer walls is a direct source of heat loss, since the cold air which leaks into the flues in this way is raised to the boiler or economizer temperature by heat abstraction from the boiler plates and economizer tubes. The ordinary direction of heat transfer is therefore reversed, with direct loss to the efficiency of the boiler or economizer plant.

4. Calculation of the Initial Furnace Temperature—The test results of the exit gases can be made use of to calculate the temperature attained in the combustion area of the boiler furnace. The method is based upon the calorific value of the fuel and the weight of the products of combustion per pound of fuel burnt. The former figure is obtained by one of the methods of direct test described in Article iii; the latter is calculated from the results of the approximate analysis of the waste gases, as described in Section i of this article.

Taking the case there given in which the gases contained ten per cent CO_2 and no carbonic oxide or unburned hydrogen, this was found to correspond to an air excess of 1.92 times the volume demanded by theory, or to twenty-four pounds of waste gases per pound of fuel. The specific heat of these gases was, however, 0.24; therefore 5.76 British thermal units would be required to raise the temperature of these twenty-four pounds of waste gases through one degree Fahrenheit. Taking the heat value of the fuel in this case at 14,200 British thermal units, it is evident that the furnace temperature must have been $\frac{14,200}{5.76}$ or 2,465 degrees Fahrenheit.

Should the combustion of the fuel be incomplete, and carbonic oxide, hydrocarbon gases or free hydrogen be present in the exit gases, it is necessary to deduct from the thermal value of the fuel the thermal units corresponding to the amount of these gases per pound of fuel burnt. These are calculated by the method given under Section 2 of this article. The balance of heat units produced by the combustion of one pound of the fuel is then divided by the factor 5.76, as in the previous example.

Since the rate of heat transfer from the hot gases on the one side of the boiler plate to the water on the other side of the plate is dependent upon the difference in temperature between the two, and increases directly as the temperature, it is evident that a high initial furnace temperature is requisite for the most economical working of boilers. The method of calculation described above is the simplest and quickest method of ascertaining and controlling this factor in good boiler working.

5. Calculation of the Heat Losses Due to Aqueous Vapor—As pointed out in Article x, the amount of aqueous vapor in the waste gases from steam boiler plants is rarely determined, and the heat losses due to this constituent of the final exit gases are therefore largely unknown. The following calculations, however, prove their importance and the necessity for keeping the moisture in the coal as low as possible, as well as the advantage of using fuels containing a low percentage of hydrogen. The superior steam-raising efficiency of South Wales steam coal is no doubt due to its low percentage of hydrogen.

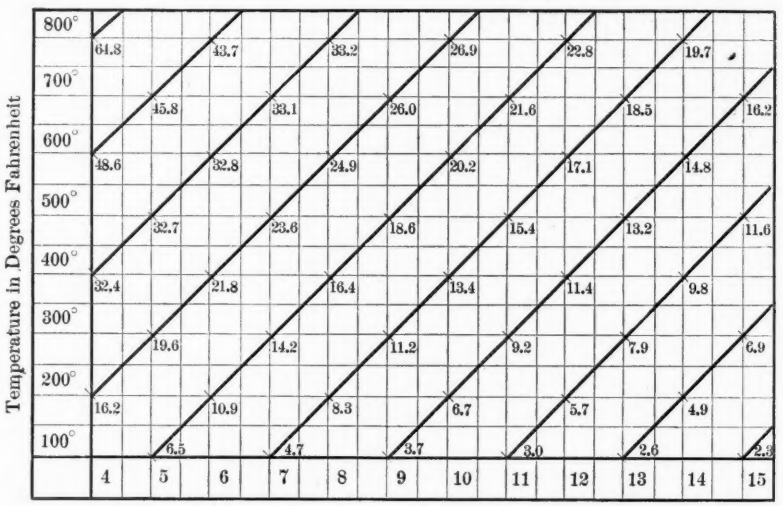


FIG. 49.—PERCENTAGE OF FUEL LOST FOR VARIOUS TEMPERATURES AND CO_2 TESTS OF EXIT GASES.

Taking the coal the analysis of which was given in Article i, we find that there was 3.05 per cent moisture and 4.65 per cent hydrogen present in the fuel as delivered.

Since hydrogen yields nine times its own weight of aqueous vapor on combustion, every 100 pounds of this coal would produce 3.05 + (4.65 × 9) or 44.90 pounds of aqueous vapor in the furnace gases, and one pound of the coal would correspondingly produce 0.449 pounds of aqueous vapor. This aqueous vapor had, however, all to be raised from the temperature of the external air to the temperature of the exit gases. In addition to the loss of heat due to the high specific heat of aqueous vapor, there was that due to the fact that all of the water passing off as aqueous vapor from the furnace of the boiler had first to be raised to 212 degrees Fahrenheit and then vaporized. Now 966 British thermal units of heat disappear in the vaporization of one pound of water, and this value is known as the latent heat of steam. The calculation for the heat lost with the moisture present in these gases is therefore made as follows, the temperature of the exit gases being taken as 665 degrees Fahrenheit, and the external air temperature at sixty-five degrees Fahrenheit:

1. Heat required to raise the moisture from sixty-five degrees Fahrenheit to 212 degrees Fahrenheit: .449 × (212 — 65) = 66 British thermal units.

2. Heat required to convert this moisture into steam at 212 degrees Fahrenheit: .449 × 966 = 433 British thermal units.

3. Heat required to raise this steam from 212 degrees Fahrenheit to 665 degrees Fahrenheit:[1] .449 × (665 — 212) × .540 = 109 British thermal units.

The total heat loss due to the presence of this aqueous vapor in the exit gases is therefore: 66 + 433 + 109 = 608 British thermal units.

With the fuel under consideration, this loss was equivalent to $\frac{608}{12,600}$ or to 4.8 per cent of the total heat value of

[1] The specific heat of steam increases with the temperature and at 665 degrees Fahrenheit is about 600 degrees.

the fuel. The chief loss is due to the latent heat of the steam, and this heat can not be recovered from the waste gases, unless they be cooled below 212 degrees Fahrenheit before passing up the chimney. Since the efficiency of chimney draught is dependent upon a temperature difference of at least 400 degrees Fahrenheit between the vapor within the shaft and the air outside it, it will be seen that until fan draught is more general, the loss of this heat is largely unavoidable. It can, however, be minimized by the use of dry fuel and the prevention of all unnecessary steam escapes into the furnaces of the boilers. The fuel tests given at the end of Article iv show that great differences exist between the moisture tests for various classes of coal, and that in washed slacks of bituminous character the moisture may rise to a very high figure.

It is therefore questionable whether the freedom from ash obtained by washing is not purchased at too high a cost; and it would be well to stipulate in buying such washed slacks or "peas" that the moisture shall not exceed five per cent in the fuel as delivered.

6. Calculation of the Heat Balance—The method of ascertaining the evaporative efficiency of the boilers by means of a "heat balance" was described in Article iv. It is unnecessary to repeat here the details of this method of calculating the efficiency of the steam-raising plant. The second entry in the heat balance given in Article iv may, however, be expanded to include all the heat losses discussed in Sections 2, 4 and 5 of this article.

The heat balance is then set out as follows:

Heat value of fuel in calorimeter.	British Thermal Units.
1.—Losses by radiation, etc.	—
2.—Losses by waste gases:	
(*a*) due to excess air	—
(*b*) due to unburned carbonic oxide	—
(*c*) due to unburned hydrogen and hydrocarbons	—
(*d*) due to moisture	—
3.—Losses by unburned carbon in cinders and ash	—
4.—Losses by heat carried in cinders and ash	—
5.—Balance, heat converted into steam	—

The difference between the total of the items 1-4 and the heat value of the fuel as ascertained by the calorimeter then gives the total units of heat converted into steam, and from this the evaporative efficiency of the boiler or boilers is obtained by expressing the result as a percentage of the total heat available. It is important that the heat value of the undried fuel be used in these calculations, and not the heat value of the dry fuel as usually returned by the chemist. The former can be calculated when the latter is known.

Fig. 49 shows in graphic form the percentage of fuel wasted by heat losses in the exit gases at various temperatures and percentages of CO_2. It is based upon a table given in the appendix of the book named below.[1]

Tantalite in Australia.

A very important feature of the Wodgina tin field, in Western Australia, according to the last annual report of the Department of Mines, is the tantalite lode. The lode traverses the whole length of two of the leases applied for, namely, Nos. 86 and 87. Upon the most southerly of the two not much work has been done, operations having been confined to dry-blowing the surface along the outcrop and in the vicinity of the pegmatite vein. The principal activity is centered upon the ground embraced within the limits of No. 86. The pegmatite vein (the lode) has been opened up for a length of forty-five feet, but only to a depth of three or four feet, and exposes coarse fragments and crystals of tantalite; one fragment weighed a little over four hundredweight (448 pounds). To the west of the open cut its width is forty-one feet, while 264 feet farther its width is thirty-four feet. A shaft is being sunk in the open cut. The lode is in "greenstone country" and not in sedimentary rocks, as is the case with the tin lodes yet opened up.

It is estimated that about eighteen tons of the mineral have been taken from the surface of the lease (in 1905). This detrital tantalite results from the disintegration of the rich shoot in the vein adjoining.

About 300 feet to the west of the main tantalite lode is a smaller pegmatite vein, containing tantalite. Dry-blowers have been at work near the southern end and have obtained (in 1905) about one hundredweight (112 pounds) of the fine grained mineral.

What may be called the tantalite group of lodes has been followed with more or less interruption for about a mile to the north of the tantalite lease No. 86; it eventually merges into the granite underlying the plains. A fair quantity of detrital tantalite has been obtained from this locality and there is every reason to believe that the area over which the mineral occurs will be extended.

As much as $4.37 per pound for eighty per cent ore was paid early in 1905 in London. Prices rapidly fell, however, owing to the large production and limited demand, to about one-sixth that price.

Tantalum was first detected in Western Australia in Greenbushes stibiotantalite (tantalate of antimony) in 1896. Subsequently, in 1900, tantalite (tantalate of iron) was detected in alluvial material from Greenbushes; manganotantalite (tantalate of manganese) in 1904 in material from Wodgina (Pilbara gold-field); manganocolumbite (niobate and tantalate of manganese) and calciotantalite (tantalate of lime and iron) in 1905 from Wodgina and Green's Well (Pilbara gold-field).

At Greenbushes tantalite has been found *in situ* as a constituent of a highly micaceous greisen, but is most frequent in water-worn pieces from the size of fine shot up to thirteen pounds in weight, associated with stream tin ore. An analysis of a detrital specimen yielded 80.61 per cent of Ta_2O_5 and 2.5 per cent of Nb_2O_5.

Associated with the tantalite, but in much smaller and less frequent pieces, is the unique mineral stibiotantalite. It is found forming thin veins in tantalite, of which it is almost certainly an alteration product due to the passage of antimonial solutions through cracks in the parent mineral, and also occurs in water-worn fragments from the size of a pin's head up to about two inches in diameter. Most of these consist of pure yellow stibiotantalite, but some consist of an ill-defined black core of tantalite surrounded by yellow stibiotantalite. It is always more or less well crystallized and exhibits one very distinct cleavage. Assays of various samples showed from 50.57 to 51.05 per cent Ta_2O_5, and 4.49 to 12.58 per cent Nb_2O_5.

At Wodgina and Green's Well manganotantalite and manganocolumbite occur in detrital fragments from small grains up to thirty-seven pounds in weight associated with more or less tin ore, as well as *in situ* in veins of albite-granite. Specimens are frequently well crystallized.—*Mining World.*

The "Electrician" Electrical Trades Directory and Handbook.

The *Electrician,* Salisbury Court, Fleet street, London, E. C., announces the preparation of the twenty-fifth edition of the "Big Blue Book," which will be ready January, 1907. This will contain the usual list of British, colonial and foreign engineers and manufacturers, technical and commercial tables and other useful data, together with an illustrated biographical section. This is one of the most useful electrical directories published and will be corrected up to January, 1907.

[1] "Smoke Prevention and Fuel Economy" by Booth and Kershaw, Constable, 1904.

RECENT STORAGE BATTERY IMPROVEMENTS.[1]

BY SHERARD COWPER-COLES.

(Concluded.)

SOLID CELLS.

In the year 1890, Hatch, of Boston, Mass., used grooved earthenware separators and filled his negative and positive active material into either side of the separators themselves. The current was drawn off by conductors of plain sheet lead, which were placed between the separators. The whole was placed together, so that absolutely no space at all was allowed for the electrolyte. It was the failure to recognize the necessity for the diffusion of the electrolyte, or at any rate, means for supplying the active matter with sufficient electrolyte close at hand to do its work, which was fatal to the Hatch cell. So long as only a very small current was required from the cell, it was fairly efficient, but if any real work were attempted, if it were put on at, say, a two-hour rate, the voltage immediately dropped to an unworkable figure. It is, however, a remarkable fact that if Hatch, instead of filling up the whole of the space with active matter, had merely coated the porcelain slabs with a film of active matter, he would, as will be shown later on, have fulfilled all the conditions which are called for today in the solid network type of cell.

It was, perhaps, an instinctive feeling that they were on the right track that caused so many, in spite of discouraging results, to follow in Hatch's footsteps. Usher, Washburn in 1892, Roe and Sutro in 1893, and Menges in 1895, made some trifling improvements, but did not remove the chief defect of the cell. In England, recently, these cells were being made under the Hatch patents by Messrs. Sutherland and Marcuson (who have transferred their rights to Messrs. Peto and Radford), and under the Hathaway patents by the Taipo Accumulator Company. Several years ago the Hatch cells were being made in America by the International Storage Battery Company in Boston, Mass., and have been revived again by the Hatch Accumulator Company, of Boston. The positives are now enclosed in a porous stiff pottery envelope, which is claimed to prevent the disintegration of the active matter. The entire surface of the new Hatch metallic electrodes is covered by active matter, which no doubt prevents the corrosion of the metallic cores.

Messrs. Peto and Radford are now manufacturing the Umpire type of plate in London, partly under the Hatch patents and partly under patents taken out by Messrs. Sutherland, Marcuson and Niblett. Owing to internal resistance of the porous plates, which are used as separators, the battery is chiefly suitable for the discharge of comparatively small currents. The makers claim that the best working figure is at the ten-hour rate, but that it is possible to discharge at seven, five and three-hour rates with proportionate drop in the voltage, and that this drop is only due to internal resistance, and not due to the electrolytic condition of the cells.

NETWORK CELLS.

From the preceding remarks it will be gathered that there is a decided movement in the direction of making storage cells solid, and doing away with the reserve acid-space between the plates. This, of course, will always result in failure so long as the additional space is not provided for the electrolyte, and that at the right place. To bring the greatest percentage of active matter in contact with its share of electrolyte, it is necessary that the surface should be very large, as in a Planté positive plate, the Tudor being a good example.

The same success, however, has not attended the Planté negative. Unfortunately, the Planté negative must, of necessity, be made by reversing a Planté positive. When positive active matter (the highest oxide) is reversed into spongy lead, much oxygen has to be removed, and a very highly molecular, porous, and therefore mechanically weak, active matter results, with consequent drop in capacity. This, of course, does not apply to the positive, because it derives a fresh supply of active matter from its metallic support. It has been attempted to work toward the same end in pasted plates by making them thinner, which necessitates increasing their number. This, of course, shortens the life of the electrode, as the thin plates, with open space each side, are mechanically very weak.

The very next year after Hatch produced his cell, Morrison, of Chicago, in 1891 attempted to meet these conditions by modifying the pasted plate type. The Universal Electric Storage Battery Company, of Chicago, is still making his cell, which has a remarkable construction, and appears to be giving very excellent results, the general design of the electrodes being in the direction of a solid network. Each electrode is built up of a number of thin pasted plates, placed horizontally, after the manner of the lamelles of the Planté plate. The cost of preparing and putting together the many little shelves of each electrode must be considerable, each small grid having to be first cast and pasted. All the thin pasted grids are then assembled, between each being placed a kind of sandwich composed of two pieces of prepared paper, and one piece of prepared grooved wood; a strip of lead is then burnt on to the ends of the shelves, and a big lug on the top. Each plate may be said to consist of a number of trays of active material exposed on both upper and lower sides to the action of the electrolyte, which can circulate through the openings of the grooved wood. There is electrolyte between each shelf, the electrodes being put very close together. The surface of active matter exposed in the electrolyte is thus very large in proportion to the sides of the electrode. A Morrison cell, rated at 450 ampere-hours, was tested in Chicago. The ampere-hour efficiency was found to be at a twenty-hour charge and discharge 90.8 per cent, at a five-and-one-half-hour charge and a two-and-three-quarter-hour discharge seventy-four per cent, and the watt-hour efficiencies at the same rates were 83.66 per cent and seventy-four per cent, respectively. The cell was said to have been severely abused for some time, after which it was found to be practically unchanged.

The same idea of an electrode built up of a number of small electrodes placed horizontally has been carried out in a modified manner by E. A. Sperry, and his cells are being made by the National Battery Company, of New York. The small grids filled with active materials are attached to the main frame of the electrode at the upper side only, space being thus provided for expansion to take place on the other three sides. The positives, however, are not pasted, as in the Morrison cell, but each positive electrode is made up of similar but Planté-formed units.

The Bijur battery made by the General Storage Battery Company, New York, is very similar to the Sperry design. The electrodes of the Morrison, the Sperry and the Bijur type, built up of small units so as to form a network, are suggestive of possible improvements in the Planté plate. As now made, however, they are mechanically very weak, and the separate units have still the old fault of liability to warp out of shape and destroy themselves.

A good example of improvement in the direction of the Sperry is a light-traction positive plate, made by the Fulmen Accumulator Company, of Paris. It consists in the first place of a bar of antimony-lead in the centre serving to support lamelles

[1] Paper read at the Royal United Service Institution, London England, before the Society of Engineers, November 5.

of soft lead, which stand out on each side in sets like wings. This arrangement of the lamelles causes each to be under the same conditions and insures the uniformity of the formation. They are burned to the supporting bar at one end only, so that they are free to expand individually in all directions without causing warping or distortion, which is a frequent cause of trouble in the ordinary Planté plate.

The Climax (made by Pritchetts and Gold) is also a good type of Planté plate. The lamelles of this plate are not cast, but are rolled up by rows of little wheels acting simultaneously on either side of the plate, resulting in a very much larger surface than it is possible to obtain by casting; rolled metal is also more homogeneous than cast.

SOLID NETWORK CELLS.

Perhaps the first serious attempt to produce a solid network cell with some provision for the electrolyte was by Niblett. His cell, in its original form, was, to all intents and purposes, of the Planté type. Each electrode consisted of a highly cellular mass of material, which filled the cell completely, and was claimed to be so constructed that it was capable of absorbing sufficient electrolyte within itself, and obviating the necessity for providing extra acid space as in the ordinary plate cell. The electrodes were merely separated by a thin, porous, inert partition. The cellular construction was arrived at in a very simple manner. Each electrode consisted of a number of small irregularly shaped pieces of lead, which were filled into the cell and then formed Planté style. These irregular pieces were made in an ingenious manner by dropping red-hot lead into water. The cell was not introduced without much opposition, although it by no means stands alone as an example of the solid network type in England and other countries.

Engineers generally, and especially most of those connected with storage-battery work, still look very unfavorably upon attempts to put the electrolyte within the electrode. The specifications of engineers usually stipulate the following conditions: Electrodes to be suspended, positives Planté, negatives of the Sellon type, acid space so much, space below plates so much, separation glass tubes, discharge down to so many volts (no matter at what rate of discharge), and so on. The introduction of the Niblett and similar cells has entirely revolutionized the mechanical construction of accumulators, enabling them to be constructed without plates, glass-tube separators, acid space, etc.

An illustration of the difficulty engineers find in regarding storage-battery matters in other than conventional and stereotyped form was given recently. An electrode of the network type was sent to a prominent manufacturer for him to test its capacity, efficiency, etc. The cubical contents of the network electrode included, of course, the acid-space within itself, but the manufacturer's engineer, who made the test, actually compared the electrode with an ordinary pasted plate (which, of course, does not include acid-space) for capacity, etc., in ratio to their cubical contents, without taking this important fact into consideration. The chief defect in the original construction of the Niblett battery was that there was no guarantee that electrodes do not consist for the most part of isolated pockets having no connection with each other, and so trap the gas and give no chance for adequate circulation of the electrolyte.

Niblett claimed that the cellular construction of the electrodes gave them the peculiar property of automatically regulating their own internal resistance, for if the cell be charged at too high a rate, or when it would be on the point of becoming fully charged, the gas would tend to drive the electrolyte from the pores of the elements, and itself to remain imprisoned therein, thereby largely increasing the internal resistance. At the same time he claimed that as the discharge proceeded the occluded gas reentered into chemical combination, and allowed the liquid to refill the pores and expose more active surface. Nothing is said about the occluded gas lowering the potential, and another serious defect in this earlier Niblett cell was the high internal resistance caused principally by the use of a porous pot, which renders it useless for central station work. The manufacturers claim, however, to have overcome this difficulty in their latest type by using a porous pot of very low resistance. In this later type the negative is a true network consisting of granules of active matter, or of a mixture of active matter and diatomaceous earth, thus avoiding the isolated pockets. In the positive, the principal improvement is the use of a conducting rod having a very large surface for contact with the active material, which further lowers the resistance.

SOLID NON-CONDUCTING NETWORK CELL.

The foregoing shows roughly the position of affairs when the first non-conducting network cell, with film only of active matter, was produced. This may be broadly described as containing electrodes composed of a hard, porous, non-conducting substance in the form of a network of three dimensions covered or painted with a very thin film of active material. This in effect produces a complete network of active material, and inside of this again a complete network of electrolyte. To help to make this clear it may be described in other words as a non-conducting mass pierced in more than one direction with intercommunicating passages, the walls of which are covered with a thin film of active material. The thickness of the film of active material and the capacity of the passages for electrolyte are said to be so proportioned that each particle of active matter has in contact with it its proper quota of electrolyte.

At the same time that the experiments of Fennell and Perry were being made, which led to the non-conducting network cell, Niblett was going over practically the same ground, and a great many of these remarks apply as well to his granule cells. The first solid network cell closely resembles the Niblett solid cell in appearance. There is this difference, however, between the two: Fennell and Perry appear to insist on a complete network of non-conducting substance, independent of the active matter, but itself supporting a film of active matter. Niblett, on the other hand, makes his granules entirely of active matter, or of a compound of active and inactive matter, or of a mixture of active-matter network with metallic network. There is, however, in either case no need of the extra acid space between the plates, and the electrodes can be set up close together, having only a thin insulator of any suitable material between them. The electrodes fill the entire cell, and so warping is impossible, even if it were not already so by reason of the subordinate part from a mechanical point of view that the active matter now plays. As a material for the non-conducting network support, the best results have been obtained with pumice stone. Niblett, on the other hand, prefers diatomaceous earth for mixing with his active matter.

From its very nature and organic origin, diatomaceous earth is obviously one of the finest inert absorbents known, and is used as such for making nitroglycerine. It is, however, very soft, as is testified by its use, as fullers' earth. It is an essential condition that the non-conducting substance should be hard, rough, porous, insoluble and non-conducting. This description would apply almost exclusively to pumice. The ideal, however, appears to be on a basis of a homogeneous, non-conducting network. This could not very well be pumice, because, although of the same chemical constituents as diatomaceous earth, it has an inorganic origin, and is too brittle to stand drilling, sawing

or working into a network. It became necessary, therefore, to imitate the qualities of pumice in some plastic material like clay, which could be afterwards baked hard. A network is thus built up entirely of one piece, and of the most desirable

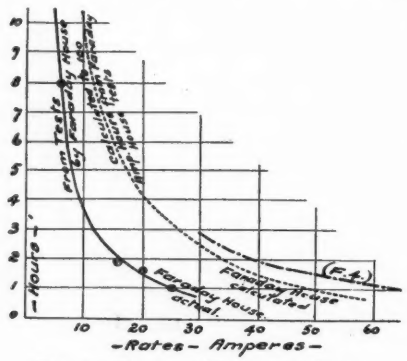


FIG. 9.—TESTS OF PANTHODE CELL.

material, which is then coated with a film of active matter, this film lining the intercommunicating passages throughout. The results given in this paper, however, were obtained from cells in which small, rough pieces of pumice were filled into the spaces reserved for them, thus forming a network of three dimensions. When the intercommunicating spaces between the pieces of pumice are lined with a film of active matter, the result is a network of inactive material supporting the network of active material, and in this again a network of electrolyte—all fitting, as it were, like one glove within another. In this cell and in the Niblett type, great attention must be paid to the method of conducting the current away. The difficulty is greater in the Niblett, however, because the conductivity depends not only on the contact with the conductor, but on the contact of the granules one with another, while in the Panthode the active matter is continuous. In the Electrical Ignition Company's type of Niblett cell the positive in the porous pot has a rod

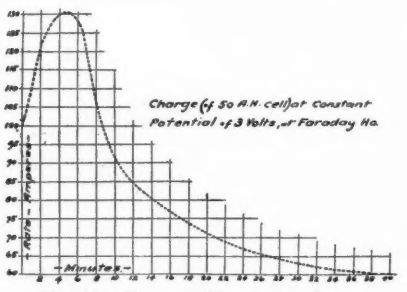


FIG. 10.—TEST OF PANTHODE CELL.

in the centre for a conductor, while the negative is served by a strip of sheet lead. In Fennell and Perry's Panthode cell similar means are adopted. The Panthode appears to involve an entirely new principle in accumulator construction, which is capable of wide application.

FARADAY HOUSE TESTS.

The first independent tests were made (see Fig. 9) by the Faraday House Testing and Training Institution in August, 1903, and the report was not received until October 23. The cell, meanwhile, received constant and severe treatment. This was, of course, before the non-conducting networks were made in one piece, and therefore the network was by no means an ideal one. A thin, perforated sheet-lead conductor ran through the centre of the electrode. The non-conducting network consisted of small rough pieces (or granules) of pumice piled on each other. When in position in the electrode, the film of future active matter (of the Lithanode type) was precipitated on the surface of the pumice and of the conductor. In doing this, great care had to be taken not to accidentally fill up any of the spaces or intercommunicating passages between the pieces of pumice. The containing box was made of celluloid, and its dimensions were four and one-quarter by four and one-quarter by ten and one-quarter inches high outside. A

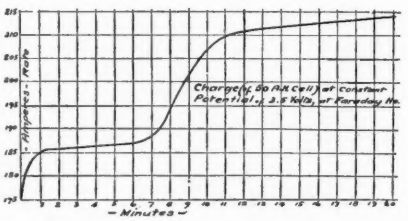


FIG. 11.—TEST OF PANTHODE CELL.

discharge of six amperes was first made, and also another last of all at the same rate in order to ascertain whether the intervening severe treatment had injured the cell.

	Ampere-hour Output.	Watt-hour Output.
First discharge.....	48	86
Last discharge.....	48	89

The capacity was unchanged, but the watt-hour output was improved in spite of the rough treatment.

The tests included charges at constant potentials of three volts and 3.5 volts, when current rose to 214 amperes, and the cell was completely charged in twenty minutes (see Figs. 10 and 11). Fig. 9 shows all discharges taken by Faraday House.

THE AUTHOR'S TESTS.

After the above treatment the cell was sent to the author's laboratory, and after a number of tests it was found that the capacity had risen to fifty-two ampere-hours, or four ampere-hours higher than it was in the first test. About a year ago several more electrodes were sent for testing. They were each ten by nine and one-half by three-quarters inches—of the same size as some Planté positives, and pasted negatives of well-known make which were to be tested with them. They

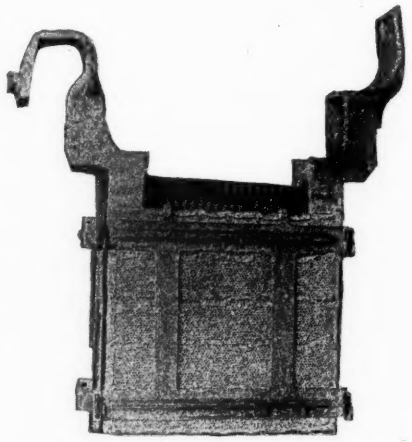


FIG. 12.—SIDE VIEW OF PANTHODE CELL.

contained sufficient room for electrolyte within themselves. A five-plate cell was made up which consisted of three Panthode negatives and two Planté positives of well-known make. A five-plate cell was obtained from the same maker for the purpose of comparison. After a few tests the sizes were found to be inconveniently large for the tests, and the cells were

FIG. 13.—END VIEW OF PANTHODE CELL.

therefore dismantled and remade as follows:

PARTICULARS OF THE FOUR CELLS TESTED, EACH CONTAINING ONE POSITIVE AND TWO NEGATIVES.

	Positive.	Negative.
F_1.....	Planté.	Pasted plate.
F_2.....	Planté.	Panthode.
F_3.....	Planté.	Panthode.
F_4	Panthode.	Panthode.

The Panthode negatives in F_2 were covered with perforated lead, and those in F_3 and F_4 were uncovered. Figs. 12

and 13 are side view and end view, respectively, of cell F_4.

The tests undertaken were for the purpose of determining the comparative value of the Panthode solid network electrodes, and other makes with regard to volume resistance, output, efficiency and durability. For the purpose of comparison, calculations were made to bring every cell to a common basis of ten amperes for ten hours. There is one point that should be mentioned before giving any details of the tests. Cell F_4 was the only one containing a network positive. This plate was assembled in a half-formed condition to save time, as indeed is now becoming the common practice. It has frequently been done with the Panthode electrodes, and has hitherto made no difference to their due and proper formation by actual use. At the end of the tests, however, when the cells were dismantled it was found that the positive was still not completely formed.

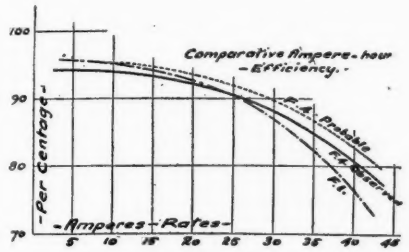


FIG. 14.—COMPARATIVE AMPERE-HOUR EFFICIENCY.

There is little doubt that this was due to an accident which occurred almost at the outset of the work. The cell was to be left on charge all night from 6 P. M. By some mistake the charging dynamo was stopped, so that for fifteen hours the already discharged cell was practically shorted through the silent dynamo. This would not have harmed a fully formed electrode, but in the half-formed state it had the effect of retarding further formation. Under normal conditions a network electrode can be formed very rapidly, because so large a surface can be simultaneously acted upon. A negative network was completely formed in three hours, but, of course, the positive takes longer. The only correction necessary to make is in the efficiency curve. The efficiency is essentially comparative, and required no conversion to the ten-hour rate. In Figs. 14 and 15 the full lines show the observed efficiencies of F_4 and the dotted lines the probable efficiencies. A large number of discharges were taken from all four cells to determine the relative ampere-hour capacities, and the results are shown on Figs. 16, 17 and 18, which give the capacities at various rates for F_1 and F_4. The result is what might be expected. At high rates the advantage is all with the network type of electrode. At very low rates the long, attenuated pores in the ordinary pasted plate for escape of gas and excess of electrolyte to active matter are perhaps sufficient. This, however, becomes a more and more important factor as density of current increases. Although these curves were made from many discharges, it will only be necessary to show several discharge curves for the characteristic of this type of cell to be at once seen.

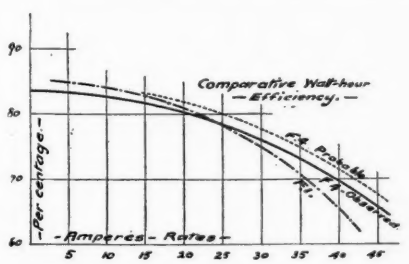


FIG. 15.—COMPARATIVE WATT-HOUR EFFICIENCY.

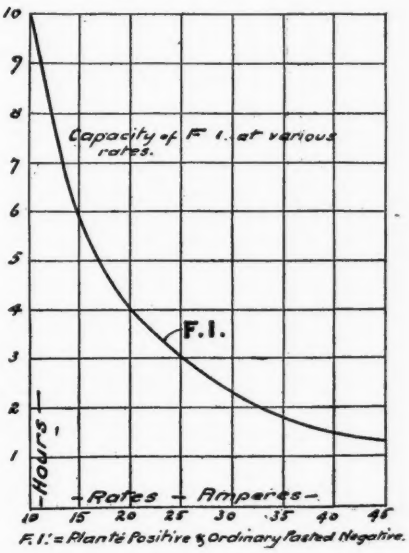


FIG. 16.—AMPERE-HOUR CAPACITY TEST.

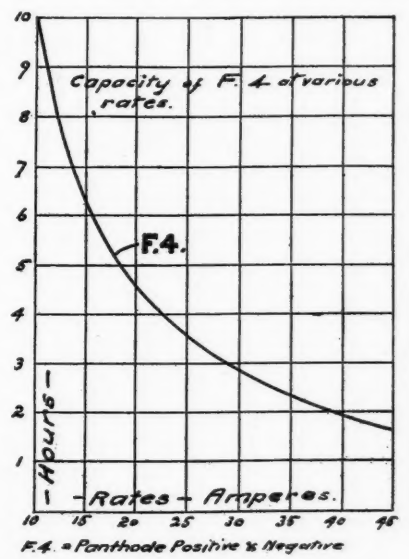


FIG. 17.—AMPERE-HOUR CAPACITY TEST.

It will be observed that in every case the usual sudden drop in the curve is practically absent. It is modified to such an extent that a working current can be obtained from the cell up to the last gasp. This characteristic has also been observed in the Niblett cells. It is a valuable quality in the case of any work which the battery may be called upon to do, but especially so when used to propel electromobiles. From its construction it is also obvious that a network electrode can be more safely discharged to zero, because a dangerously high or dangerously low density of electrolyte is less likely to be produced. The ratio of output to volume of electrode may be roughly considered to be identical with the actual outputs. The network electrodes used in the tests (containing acid space within themselves) filled about the same space as the electrodes in the ordinary cells, plus the acid space between the plates. For instance, an ordinary electrode and glass tube separators may be considered as removed, and the network electrode and thin corrugated, perforated ebonite or asbestos cloth put in its place.

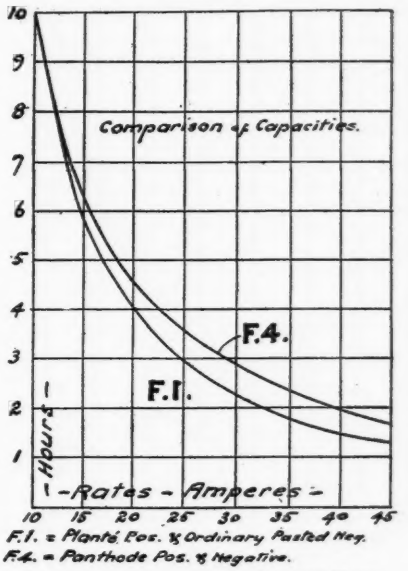


FIG. 18.—COMPARISON OF AMPERE-HOUR CAPACITIES.

Another characteristic of these network electrodes, which came out in the capacity tests, is their remarkable indifference to high rates of charge. This was much more in evidence in the efficiency tests.

In order to make the conditions as near as possible to actual practice all the results, whether obtained for the express purpose of determining efficiency or not, were included as material for plotting the comparative efficiency curves. The efficiency cycles were all comparatively short, and were started in a dis-

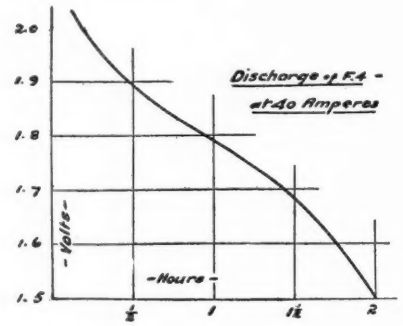


FIG. 19.—DISCHARGE OF F_4 AT FORTY AMPERES.

charged condition—discharged down to the proposed standard cut-off point curve. Take, for instance, a one-hour cycle at a forty-ampere rate; the work would be in the following order:

1. Put cell in discharged condition by discharging at forty amperes down to 1.5 volts.

2. Charge for one hour at forty amperes.

3. Discharge at forty amperes until potential difference equals 1.5 volts.

For a two-hour cycle at the normal rate it would be as follows:

1. Put cell in discharged condition by discharging at seven amperes down to 1.85 volts.

2. Charge for two hours at seven amperes.

3. Discharge at seven amperes down to 1.85 volts.

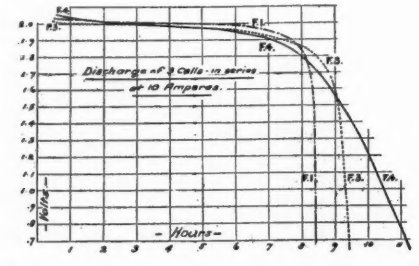


FIG. 20.—DISCHARGE OF THREE CELLS IN SERIES, AT TEN AMPERES.

It has often been attempted to use the open-circuit voltage to mark the start and finish of an efficiency cycle. It has been found, however, that the open-circuit voltage is unreliable as an indication of the electrochemical condition of a cell, and even by the method used, 100 per cent efficiency was sometimes obtained, thus showing how extremely difficult it is under any circumstances to determine the actual electrochemical condition of the cell. The best way is the one the author has adopted, that of taking a number of consecutive charges and discharges at a constant rate, noting every watt that goes in and that comes out. In this diagram of comparative efficiency at all rates, it will be seen that in efficiency, as in output, the network electrode does its best work at high rates. Fig. 19, showing discharge of F_4 at forty amperes, and Fig. 20, showing the discharge of F_1, F_3 and F_4 in series simultaneously, all bear out to a more or less marked extent the characteristic of the network electrode. The tests were intended to be only comparative, so this applies also to resistance. When the cells were in a half-charged condition, the ratio was approximately nine, eight and ten for F_1, F_3 and F_4, respectively. The resistance of F_4 would probably have been much lower if the network positive had been fully formed. F_2 was chosen to test the drop on open circuit, because the outsides of

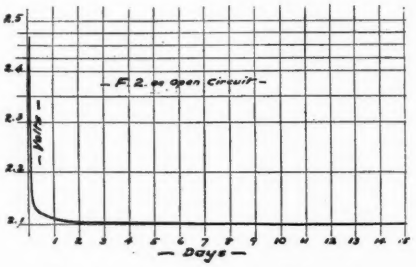


FIG. 21.—DROP ON OPEN CIRCUIT.

electrodes in that cell were covered with perforated lead, and might be expected to suffer most from local action. The result is shown in Fig. 21.

CONCLUSION.

These tests, coupled with the results already obtained, have advanced the matter much in two ways, and have led the author to the following conclusions:

1. That the networks of non-conducting substance and of active matter are each in themselves continuous and homogeneous. The contact between granule and granule (which in the older types of network cells was the cause of so much resistance) is abolished.

2. That the space for electrolyte is also continuous and intercommunicating, so that the gas can now freely escape, and, in addition, provision is made for the access to each particle of active matter of its necessary quota of electrolyte.

There is, however, still one weak point in the network cell, which the Panthode battery or the Niblett solid battery have not completely solved, *viz.*: the contact of the active matter with the conductor for the purpose of leading the current away.

The author has endeavored in particular to explain the various stages of development of network storage cells, and to point out the directions in which improvements are likely to occur, such as the proper regulation of the physical effects, other than the electrochemical effects, which are known to exist, but have not been turned to advantage.

Electric Power in the Transvaal.

It was stated recently that the scheme for the electrical transmission of power from the Victoria Falls of the Zambesi river, Africa, was being held in abeyance, and that plans were being developed to establish a steam-power generating station on the Witwatersrand, the intention being to take up the hydroelectrical development at a later period. On this subject the London *Electrical Review* quotes from a correspondent of the *Frankfurter Zeitung,* who states that there has been a gradual reduction in the data relating to the utilization of the water-power of the Victoria Falls for the production of electrical energy. The rights for developing these falls have belonged for some years to the African Concessions Company, Limited, but nothing has yet been done by the company. More accurate information seems to raise a doubt whether the falls could be depended upon to develop 15,000 horse-power during the dry season. Besides this comparatively small amount, there would be a heavy loss of power in transmitting it over 800 miles through the wilderness. For these reasons it will be necessary, in any case, to erect a steam power-station in the vicinity of the Rand as a reserve, but this would probably become too expensive to be used merely as such. It seems probable that what will be done will be to erect a new power-station, steam-driven, near the Vereeniging coal mines, on the Vaal river. A similar station already exists in the Rand Central Electric Works, on the east of the Rand, near Brakpan, and it is yet undecided whether there is sufficient demand for power to warrant the erection of a second station.

Armature Reaction in Polyphase Alternators.

By L. A. Herdt.

IN a paper presented at the nineteenth annual convention of the American Institute of Electrical Engineers in 1902 the writer advocated a method for the predetermination of alternator regulation based upon the principles laid down by Blondel[1] that, when an alternator supplies a current dephased by an angle ϕ with respect to the internal induced electomotive force, the armature reaction course on the shape of the pole-pieces and the saturation of the magnetic circuit. The flux set up by the field magnetomotive force revolves with the field structure and its distribution remains practically undisturbed throughout one revolution as with a distributed armature winding, the reluctance of the magnetic circuit for any particular position of the field structure is practically the same.

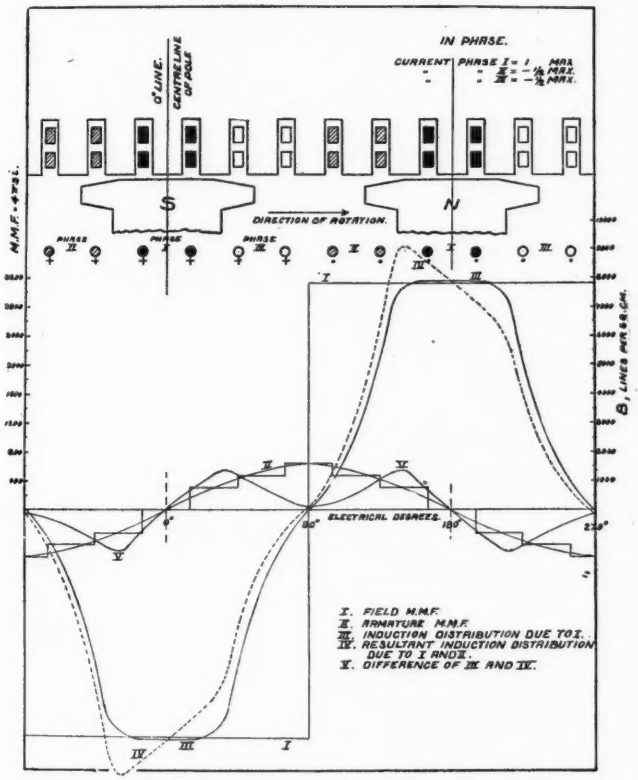

IN PHASE.
DIRECTION OF ROTATION.
ELECTRICAL DEGREES.
I. FIELD M.M.F.
II. ARMATURE M.M.F.
III. INDUCTION DISTRIBUTION DUE TO I.
IV. RESULTANT INDUCTION DISTRIBUTION DUE TO I AND II.
V. DIFFERENCE OF III AND IV.

FIG. 1.—ARRANGEMENT OF ARMATURE COILS OF A THREE-PHASE ALTERNATOR.

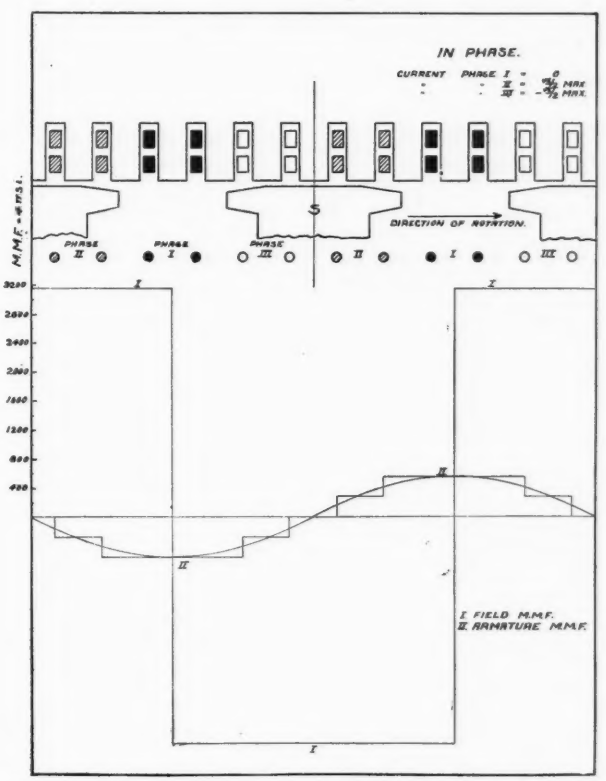


FIG. 2.—SHOWING RELATIVE CHANGES IN POSITION AT ANOTHER INSTANT.

fore also be represented by a vector revolving at the speed of the field structure; the dimension of this vector depends on the strength of the armature current, and the position it occupies relatively to the field magnetomotive force vector depends on the phase angle between the induced electromotive force and the current. With inphase current the armature magnetomotive force rotates ninety degrees behind the field magnetomotive force; that is, in quadrature with it. When the current lags ninety degrees behind the induced electromotive force, the armature vector is at 180 degrees to the field magnetomotive force; that is, in line with it but opposed to it. For other phase displacements between the current and the volts the armature lags or leads the field magnetomotive force by an angle of ninety degrees plus the angle between the current and the induced electromotive force.

Under load these two distinct magnetomotive forces, namely, the field and the armature magnetomotive forces, will set up the resultant induction distribution. The regulation of the alternator evidently depends on the change between the no-load induction and the induction set up

may be considered as the result of a direct reaction produced by the wattless component of the current (I sin ϕ), and a transverse reaction due to the watt component of the current (I cos ϕ).

The object in writing another paper on the same subject is to outline an experimental method for the determination of the regulation of alternators under load, based on the above theory.

THEORY OF ARMATURE REACTION.

In a distributed armature winding type of alternator when the field magnets are excited, the field magnetomotive force will set up in the air gap a certain induction distribution. This distribution is approximately sine form, but depends of

With respect to the stationary armature windings the field flux corresponds to an alternating flux, cutting through the armature coils, increasing and decreasing according to a sine law. The field flux, and the field magnetomotive force as well, can be represented in direction and magnitude by a vector of constant length revolving at the speed of the field structure in revolving field alternators, or fixed in space in revolving armature alternators.

When the armature carries a current, the armature magnetomotive force set up by three-phase currents in the windings is also an alternating function whose form depends upon the type of winding, but in the ordinary type of alternators it does not differ very much from a sine curve. The armature magnetomotive force can there-

[1] "The Empirical Theory of Alternators," A. Blondel, *L'Industrie Électrique*, 1899.

under load. The change from the no-load induction due to a certain value of the armature magnetomotive force will vary with the power-factor; that is, the induction set up by the armature magnetomotive force varies not only with the magnitude of the magnetomotive force but also with the position this magnetomotive force wave occupies relatively to the field-poles.

While in induction motors, for example, the distribution of magnetic induction in the air-gap can be taken directly from the distribution of the magnetomotive force, for the gap length is constant, this can be assumed smoothed out to approximate a sine curve.

At any other instant (see Figs. 2, 3 and 4), this armature magnetomotive force changes but little and the position it occupies relatively to the pole-pieces remains unchanged, assuming, of course, that the angle between the volts and the current is not altered.

The induction set up in the air-gap at no-load by the field magnetomotive force (curve I, Fig. 1) is given by curve III. This flux is calculated by taking at every point the value of the magnetomotive force acting and the reluctance is assumed as that equivalent to the air-gap alone. (Experiments that have been carried out on this machine, and which are discussed further on, show that the flux calculated in this way comes very close to the actual distribution determined experimentally.) The flux set up by the armature magnetomotive force is shown by curve V. (The lines across the slots and those which interlink with the end connections are neglected for the present.)

Curve IV is the resultant induction distribution due to the magnetomotive forces I and II. From this figure it is shown that the armature magnetomotive force with inphase current sets up a cross flux increasing the induction in one side of the pole-pieces and diminishing the induction in the other. A change in the distribution of magnetic flux is thus set up by the armature magnetomotive force, but the resultant total induction is but slightly altered. This is specially so with alternators having chamfered pole-pieces, as with inphase current the armature magnetomotive force wave, having its maximum ordinates between the poles, can not set up any marked effect of armature reaction, the reluctance being considerable.

EFFECT OF LAGGING CURRENT UPON ARMATURE REACTION.

In Fig. 5 the same method is applied to determine the distribution of armature magnetomotive force when the current is lagging ninety electrical degrees behind the electromotive force.

The distribution of magnetomotive force is the same as that for inphase currents (see curve II, Fig. 1). The magnetomotive-force wave, however, is displaced by ninety degrees from the position it held for similar values of inphase current. This rotating magnetomotive-force wave is now at 180 degrees to the field magnetomotive force and opposes it.

The induction set up by the armature magnetomotive force with quadrature current is vastly different from that set up by inphase current, although the magnetomotive-force values are unchanged for equal currents. The reluctance of the magnetic circuit is entirely different from

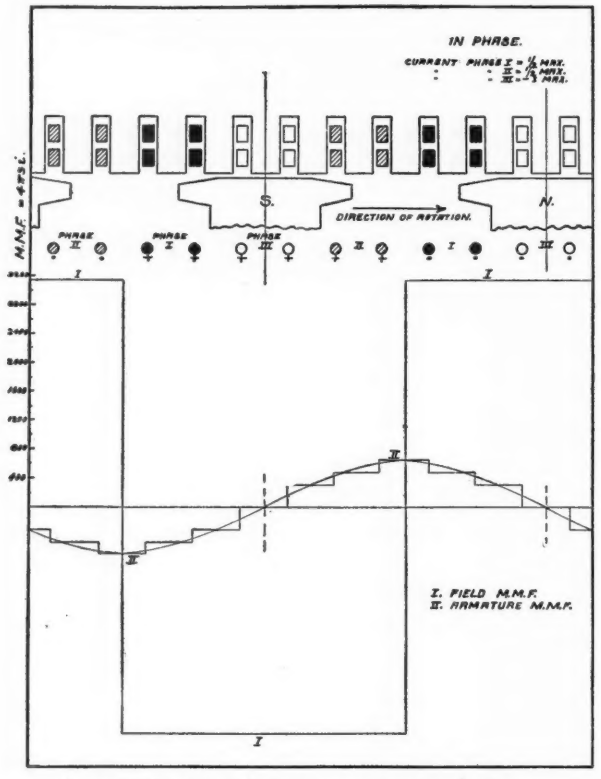


FIG. 3.—RELATIVE CHANGES AT ANOTHER INSTANT.

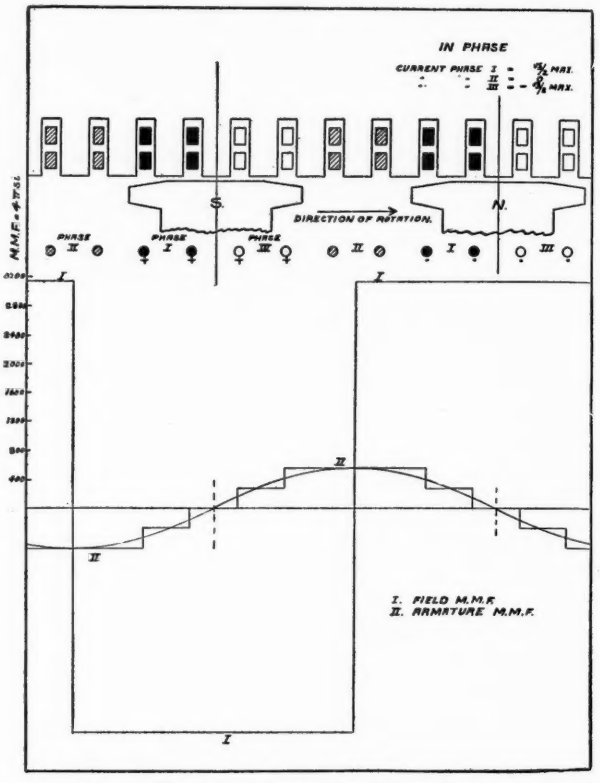


FIG. 4.—RELATIVE CHANGES AT LATER INSTANT.

will not apply, even to an unsaturated alternator, for the induction set up by the armature magnetomotive force will invariably depend upon the relative position of the armature magnetomotive force wave and the field structure.

ARMATURE REACTION WITH INPHASE CURRENT.

In Fig. 1 is shown the arrangement of the armature coils of a three-phase alternator (two slots per pole per phase).

Curve I is the field magnetomotive force. The armature magnetomotive force produced by three-phase currents assumed of sine form in phases I, II and III for the particular instant stated in the figure and for current assumed inphase with the induced electromotive force, is shown by the right-angled curve II which

that with inphase current; in this case the maximum ordinates of the armature magnetomotive-force wave act over the pole centres and the armature magnetomotive force is now directly opposed to the magnetomotive force; the reluctance of the magnetic circuit is that of the machine.

It is thus shown that the induction set up by an armature magnetomotive force with quadrature currents is greater than that set up by an equal amount of inphase current, also that the effect of the armature current in diminishing the no-load induction and varying its distribution depends on the phase relation of the electromotive force and current.

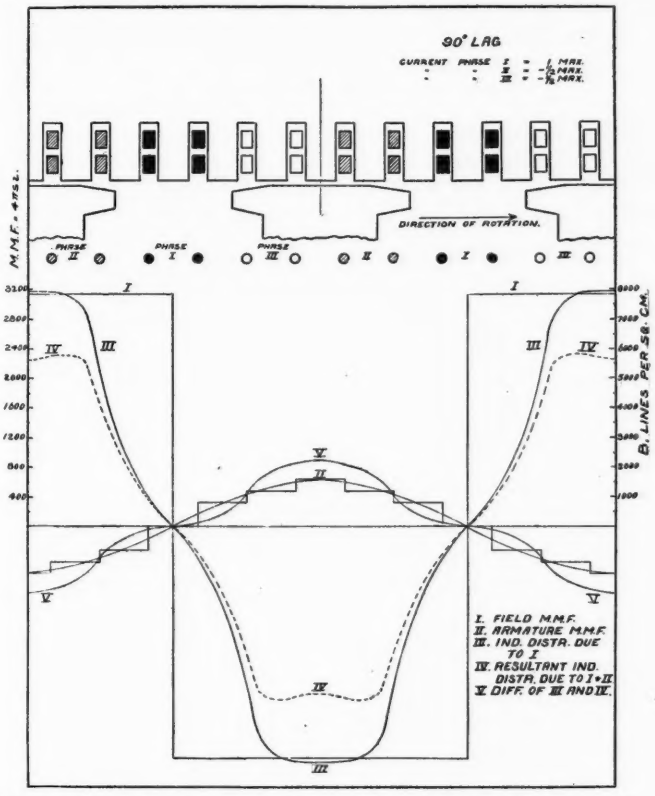

90° LAG
DIRECTION OF ROTATION.
I. FIELD M.M.F.
II. ARMATURE M.M.F.
III. IND. DISTR. DUE TO I
IV. RESULTANT IND. DISTR. DUE TO I+II
V. DIFF. OF III AND IV.
B. LINES PER SQ. CM.

FIG. 5.—DISTRIBUTION OF ARMATURE MAGNETOMOTIVE FORCE, WITH CURRENT LAGGING NINETY ELECTRICAL DEGREES BEHIND ELECTROMOTIVE FORCE.

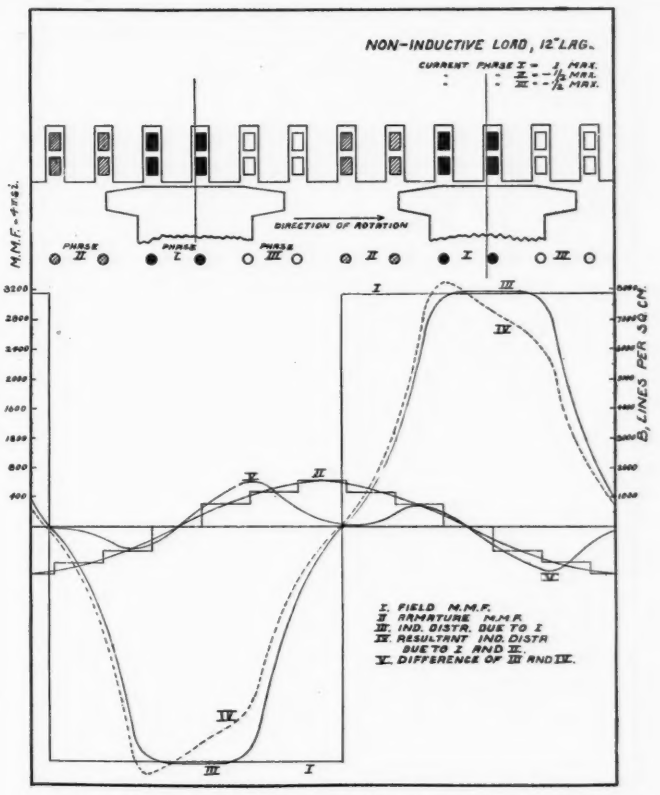

NON-INDUCTIVE LOAD, 12° LAG.
DIRECTION OF ROTATION
I. FIELD M.M.F.
II. ARMATURE M.M.F.
III. IND. DISTR. DUE TO I
IV. RESULTANT IND. DISTR DUE TO I AND II.
V. DIFFERENCE OF III AND IV.
B. LINES PER SQ. CM.

FIG. 6.—ARMATURE MAGNETOMOTIVE FORCE FOR NON-INDUCTIVE LOAD.

ARMATURE REACTION FOR NON-INDUCTIVE LOAD AND INDUCTIVE LOAD THEORETICALLY AND EXPERIMENTALLY DETERMINED.

The effect of the armature magnetomotive force on the no-load induction distribution has also been worked out (1, for non-inductive load, Fig. 6; 2, for an inductive load of power-factor sixty-two per cent, Fig. 7).

In the first case the current lags behind the total induced electromotive force by twelve degrees, in the second case the current lags fifty-two degrees. The different effects of the armature reaction for these two particular loads, the magnetomotive forces being equal, are shown by curve V on both figures. The effect of the lagging current in diminishing the total induction is well marked.

As previously stated, these curves are all calculated curves. Experiments were carried out to obtain these curves experimentally and to compare them with the calculated curves.

In Fig. 8 is shown the no-load induction distribution for a certain value of the field magnetomotive force.

Curve I is the calculated or predetermined curve used before. Curve II is the same curve obtained experimentally. The induction distribution with non-inductive load experimentally determined and calculated is shown in Fig. 9, and for inductive load fifty-two degrees lag in Fig. 10. These curves show that the effects of armature reaction can be calculated very closely.

ARMATURE REACTION.

The above discussion shows that armature reaction, including the cross-magnetizing effect, the demagnetizing effect, and the armature leakage, can not be expressed as an equivalent reactance, irrespectively of the lag or lead of the armature current. Any method to predetermine correctly the regulation of an alternator that does not take into account these separate effects of the armature magnetomotive force must be incorrect.

When the armature current lags behind the nominal induced electromotive force by an angle between zero and ninety degrees we may regard the armature magnetomotive force as made up of two components, a quadrature component and an inphase component.

DIRECT REACTION.

The quadrature component of the magnetomotive-force wave has its maximum ordinates over the pole centres and sets up the demagnetizing effect. This can be expressed either in ampere-turns and the demagnetizing effect measured off as KNI sin ϕ, ϕ being the phase angle between the current and the volts, or as an equivalent reactance X_1 and this multiplied by I sin ϕ, the quadrature current (I sin ϕ X_1), will give the demagnetizing effect. The value of X_1 can be experimentally determined, as will be shown presently.

TRANSVERSE REACTION.

The inphase component of the magnetomotive-force wave has its maximum ordinates midway between the pole centres and sets up the cross-magnetizing effect. This is equal to a constant X_2, and this

multiplied by I cos ϕ the inphase current (I cos ϕ X_2) expresses the cross-magnetizing effect due to the inphase current.

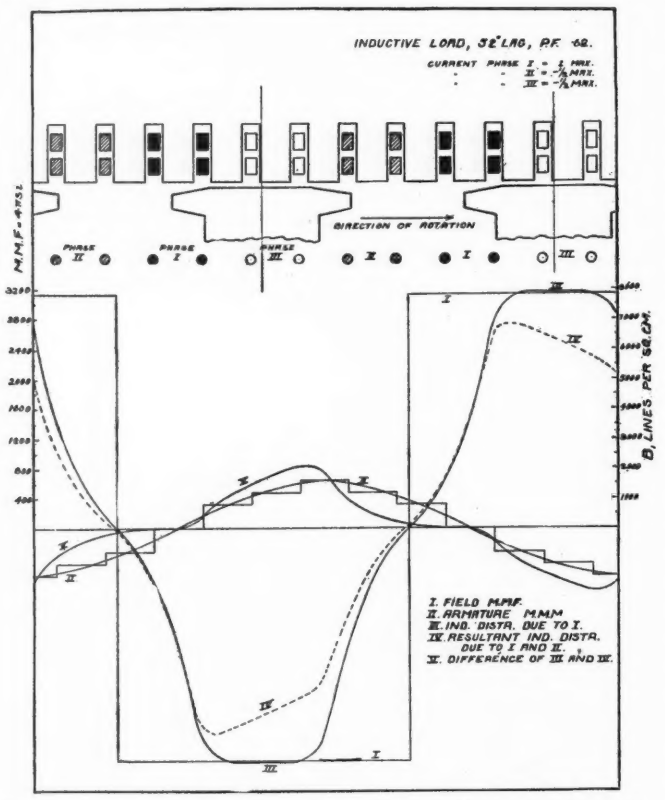

INDUCTIVE LOAD, 52° LAG, P.F. .62.
CURRENT PHASE I = I MAX.
II = ½ MAX.
III = ½ MAX.
M.M.F. = AMPS.
DIRECTION OF ROTATION
PHASE II
PHASE I
PHASE III
B, LINES PER SQ. CM.
I. FIELD M.M.F.
II. ARMATURE M.M.F.
III. IND. DISTA. DUE TO I.
IV. RESULTANT IND. DISTA. DUE TO I AND II.
V. DIFFERENCE OF III AND IV.

FIG. 7.—ARMATURE MAGNETOMOTIVE FORCE FOR INDUCTIVE LOAD OF POWER FACTOR 0 62.

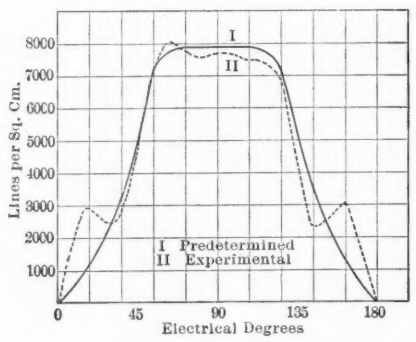


FIG. 8.—NO LOAD INDUCTION DISTRIBUTION.

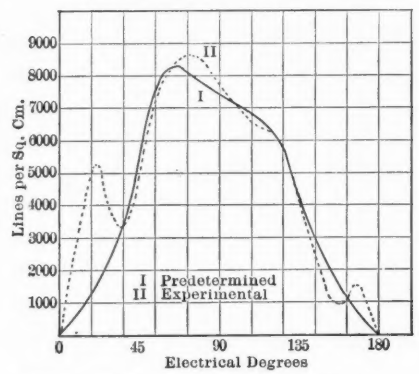


FIG. 9.—NON-INDUCTIVE LOAD, TWELVE DEGREES LAG.

The value of X_2 can also be experimentally determined.

LEAKAGE REACTANCE.

The leakage flux encircling the armature conductors is entirely independent of the lag or lead of the current, but as it varies directly with the current it can be expressed in the form of IX_3, X_3 being an equivalent reactance.

EXPERIMENTAL DETERMINATION OF X_1, X_2 AND X_3.

Demagnetizing Component of Armature Reactance (X_1)—X_1 can be determined experimentally by working the alternator on a purely reactive load so that the demagnetizing effects of varying quadrature armature currents with full field excitation are determined. It is advisable as stated to determine these effects with full field excitation and not an excitation just sufficient to circulate full-load current through the armature short-circuited as is ordinarily done. X_1 is essentially variable for different armature current intensities on account of the saturation of the iron.

Cross-Magnetizing Effect of Armature Reaction (X_2)—X_2 can not be taken at a value equal to the synchronous reactance X_1 obtained in the test with quadrature current. It is, however, proportional to X_1; that is,

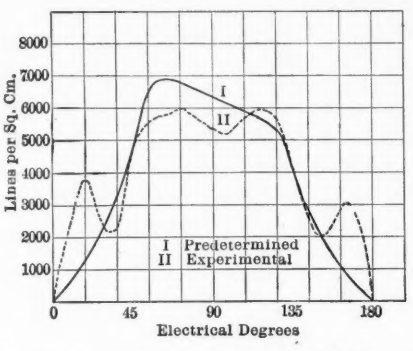
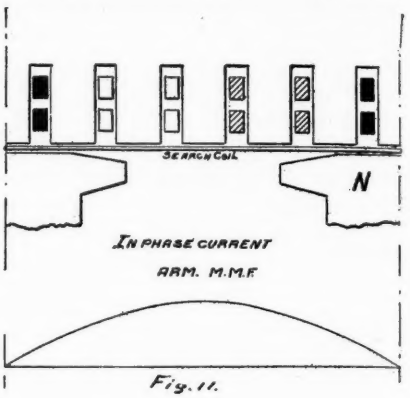
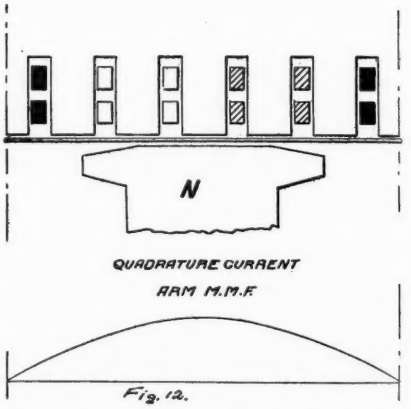


FIG. 10—INDUCTIVE LOAD, FIFTY-TWO DEGREES LAG, POWER FACTOR, 0.62.

Knowing X_1, the ratio of these two reluctances is all that is required. This value is determined experimentally as follows: A search coil of width equal to the pole pitch and encircling the armature is placed in the air-gap and connected to a galvanometer or voltmeter; the fields are excited. A direct current equal to I maximum value is passed in phase I, and half maximum values in phases II and III; the poles are placed first in position, relatively to the search coil, as shown in Fig. 11, the armature current is reversed or broken, the poles are then placed in position relatively to the search coil as shown in Fig. 12 and the armature current again broken or reversed. The ratio of the deflections of the galvanometer or voltmeter is the ratio referred to above. X_2 is thus obtained.





FIGS. 11 AND 12.—RELUCTANCE OF MAGNETIC CIRCUIT.

Armature Leakage Flux (X_3)—This flux can be determined theoretically but with difficulty. Experimentally it can be determined by measuring the reactance per phase of the alternator with the field magnets removed.

The reactance X_2 obtained in this way multiplied by the armature current I

$$\frac{X_2}{X_1} = \frac{\text{reluctance of magnetic circuit poles placed as shown in Fig. 11.}}{\text{reluctance of magnetic circuit poles placed as shown in Fig. 12.}}$$

gives the value of the electromotive force of self-induction set up (IX_2). The electromotive force acts in quadrature with the current.

ALTERNATOR DIAGRAM.

Using the values so obtained for the demagnetizing and cross-magnetizing components of synchronous reactance and for armature leakage reactance, the following diagram properly expresses the relation of electromotive forces and current in the armature of an alternator under load.

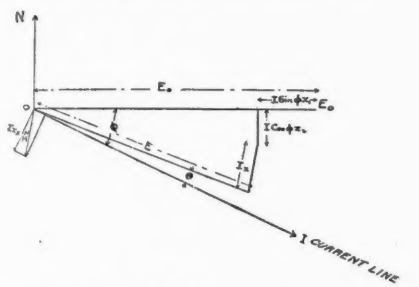


FIG. 13.—RELATION OF ELECTROMOTIVE FORCES AND CURRENT IN ARMATURE OF ALTERNATOR UNDER LOAD.

The line ON represents in direction and magnitude the field flux; this field flux sets up to total induced electromotive force (E_o); that is, the no-load electromotive force.

r = resistance of armature.

X_3 = reactance due to leakage flux alone.

I_r = the electromotive force of resistance drop set off on the current line.

IX_3 = the electromotive force set off at right angles to the current.

Iz = drop due to leakage reactance and armature resistance.

$I \sin \phi X_1$ = drop of potential due to the demagnetizing effect of the quadrature armature current that is set off along E_o line and opposing it.

$I \cos \phi X_2$ = the electromotive force set up by the cross-magnetizing effect of the inphase armature current; this is set off at right angles to E_o.

Combining all these electromotive forces, the terminal voltage E is obtained.

This method applied to a number of alternators has been found to give very accurate results. The application of this method to a number of alternators will be discussed in a paper to appear shortly.

ATHLETIC SPORTS FOR OPERATORS.

BY J. E. PEAVEY.

To be successful in the pursuit of any business or profession, it is very essential that the individual should be possessed with robust health and an amiable disposition. Of all vocations, there is none that requires these qualifications so much as the telephone operator. Her position is more or less confining, and her duties do not alone demand quickness and accuracy in her work, but she must be above all things courteous, never showing a trace of irritability, detection of which in her voice or manner would in many cases make a lasting enemy to her company of some restless, impatient and inconsiderate telephone patron, whom she has daily to deal with. In fact, she should have the disposition of an angel; her voice and manner at all times and under all circumstances being as balm to the troubled waters.

TELEPHONE OPERATORS OF THE CINCINNATI BELL TELEPHONE COMPANY EXERCISING.

To establish a well-disciplined and efficient operating force, it behooves every employé to lose as little time as possible from their work. Failure to promptly report for duty regularly will demoralize the entire force and service. To provide for these qualifications and requirements, all well-regulated telephone companies select from the various applications those that are the most robust and intelligent, and, in order to stimulate an interest in their work, provide comfortable quarters, containing books and games, and in order to further provide for their health and its consequent blessings where possible, gardens and playgrounds are provided. But above all forms of amusement and entertainment athletic sports are the most popular and far-reaching in its beneficial results, chief among which is the punching-bag shown in accompanying illustration. This photograph was taken at the West exchange of the Cincinnati & Suburban Bell Telephone Company, Cincinnati, Ohio, and shows an operator in the act of using it. These punching-bags have been in service for some time, and at no time has interest in them lagged; in fact, they are overworked, maintenance being the only objectionable feature in their use. Many operators soon become expert in manipulating the bag, and all take a hearty interest in this healthful and fascinating exercise.

Electrical Equipment of the Erie Railroad Shops at Hornell (Hornellsville), N. Y.

THE operation of machine tools by electric motors has an exceedingly wide field, but no class of manufacturing establishments exemplifies the adaptability of electric drive more than railroad shops. The large work handled necessitates extensive buildings and the use of great lengths of shafting and belting if power is transmitted mechanically from a central source. Rush repair jobs are frequent and require a great deal of overtime and Sunday work, when power requirements are small, as but sufficient machinery is operated to complete the particular work at hand. Mechanical transmission of power under such conditions is wasteful in the extreme, owing to the surplus power required to overcome the friction of shafting and belting throughout the shops. Where electric drive is used—either individual or group—a flexibility is obtained that can not be secured by any other means, as it permits the use of a few machines independently, obviating the objectionable features enumerated and permitting operation with a minimum power-house' capacity, thereby effecting a considerable saving in fuel.

There are many other considerations in connection with power transmission, one of the most prominent being the layout of the plant, which is especially important in a railroad shop, as it is generally made up of a number of separate buildings aside from the main machine and erecting shop, such as boiler shop, carpenter shop, tank shop, blacksmith shop, pipe shop, etc., which are necessarily scattered, widely distributing the power requirements and necessitating the use of a number of prime movers. Where engines are used, steam is supplied either from a central boiler plant or by individual boilers forming a combination unit with the engine. The former arrangement is poor from an economical standpoint owing to the low efficiency resulting from the usual excessive condensation which takes place in long lengths of steam pipe. Either method involves the expense of skilled attendants, which amounts to a considerable sum annually. These conditions are, however, rapidly changing; electric motors are superseding steam equipments and have many times proved that they fill all requirements—reducing operating expenses, requiring a very small amount of attention, providing power that is perfectly reliable, and reducing the time of starting and stopping and changing speed to a minimum.

Other applications may be found in cranes and in transfer and turntables, where the electric motor is superior to every other motive gear, owing to its ease of control, efficiency and reliability.

It was these considerations that led the Erie Railroad Company to abandon mechanical transmission of power and adopt the electric drive at its Hornell shops, which now utilize electric power entirely and furnish an excellent example of the expediency and use of both individual and group drive.

When the present management took charge of the Erie Railroad it adopted broad and comprehensive plans for the development of the entire property, which are rapidly making it one of the most modern and efficient railway systems in the country. These plans embraced extensive alterations and additions to the many shops of the system in order to enable them to respond rapidly and efficiently to the increasing demands made upon them by the necessary additions to the rolling equipment.

New shop buildings and roundhouses have been constructed, old machines replaced by new, an efficient shop organization effected and the entire mechanical department brought up to a high standard of efficiency. This work, under the direction of E. A. Williams, general mechanical superintendent, and G. W. Wilden, mechanical superintendent, has been carried on at many different points on the system, but the most extensive single installation of modern shop equipment is at the Hornell shops, located at Hornell, N. Y. At this point new buildings have been erected, additions made to old buildings, a new power-house erected and a large number of new machine tools, with a complete system of electric drive, installed. This installation is an interesting and instructive illustration of the latest engineering practice for a railway shop, where the largest proportion of power is required at short distances from the power-house and a large proportion of variable-speed and crane load is required.

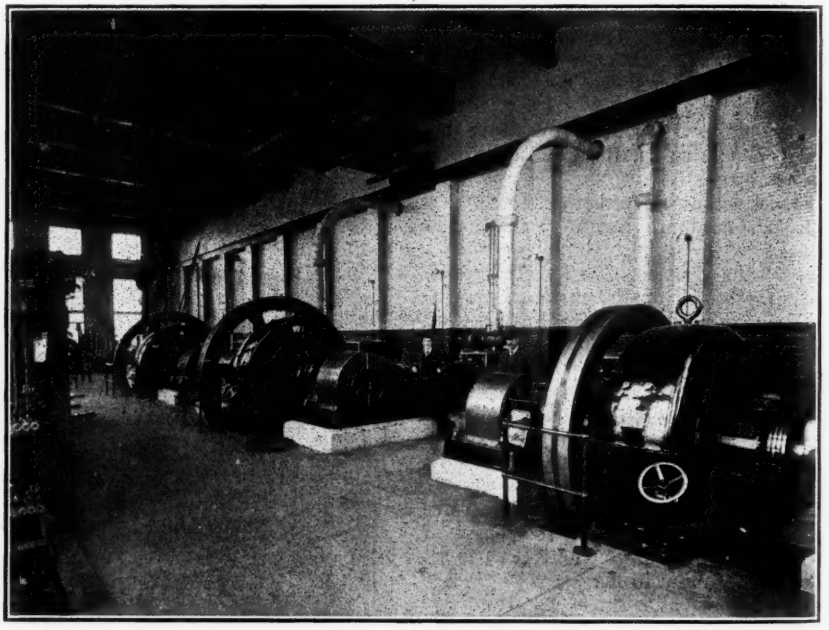


FIG. 1.—INTERIOR OF POWER-HOUSE, ERIE RAILROAD SHOPS, HORNELL, N. Y.

Before making a final decision as to the type of electrical apparatus to be installed, a careful comparison was made relative to the advantages and disadvantages of both the alternating-current and direct-current types of apparatus for the service contemplated. This analysis included not only the motors themselves, but also the various accessories, such as wiring, controllers, etc. Due considera-

tion was also given to an installation involving the use of both alternating and direct-current motors, but while it appeared probable that at some time in the future an equipment of this nature would be necessary, it was decided that present conditions do not justify the installation of both types of motors. Under the conditions existing at Hornell it is apparent that all of the motors are located well within the limits of 220 volts distribution, and in addition that there is at this time no woodworking shop in existence, therefore it was finally resolved to make the installation consist entirely of direct-current apparatus with the exception of a small generator set which is used to supply the current necessary for the present yard and depot lights. This installation is an excellent illustration of the principle that each railroad shop must be considered as a separate and independent problem, and it is impossible to lay down any hard and fast rules which can be taken as a guide, but that each particular case must be thoroughly investigated and a final decision reached in conformity with the conditions existing at that point.

As indicated above, the enlargement of the power-house at some future time has not only been contemplated but provided for. The type of apparatus to be placed in the engine room, however, will be determined upon at the time of making the addition, as the present system can readily be expanded in either of two ways. Additional power can be obtained by the installation of the necessary capacity, either in an alternating-current generator which would supply the lines direct, the present motor-generator set acting as a tie between the present units and the future one, or a direct-current generator, with the necessary transforming apparatus for alternating current, can be installed if it is found that conditions demand that this be done.

The power-house is a large brick structure of fireproof construction, with concrete roof and flooring, and has ample provision for light and ventilation. The building is large enough to provide for future extensions, foundations already being in place for doubling the boiler capacity, so that it is only necessary to erect the additional units. The interior of the power-house, showing the engines and generators, is shown in Fig. 1. The boiler plant consists of four Babcock & Wilcox units of 400 horse-power, operating at 150 pounds pressure and equipped with chain grates. All live-steam mains are provided with the Holley drip system. The coal handling and stoking is especially interesting as, from the time the coal is dumped from the cars until it is fed into the furnace, it is conveyed automatically. The coal passes from the car into a chute which empties into a crusher, and is then conveyed by an endless belt to the top of the power-house, where it passes through another chute to the second conveyer that distributes it in the bunkers over the boiler room. From there the coal passes through chutes to hoppers in front of the furnaces, where it is fed into the chain grates. The amount of coal admitted into the hoppers is controlled in the boiler room by means of levers. The conveyers, which were manufactured by the Exeter Machine Company, have a capacity of sixty tons per hour and are operated by a ten-horse-power and a thirteen-and-one-half-horse-power Westinghouse type S motor. The coal crusher is operated by a twenty-horse-power type S motor.

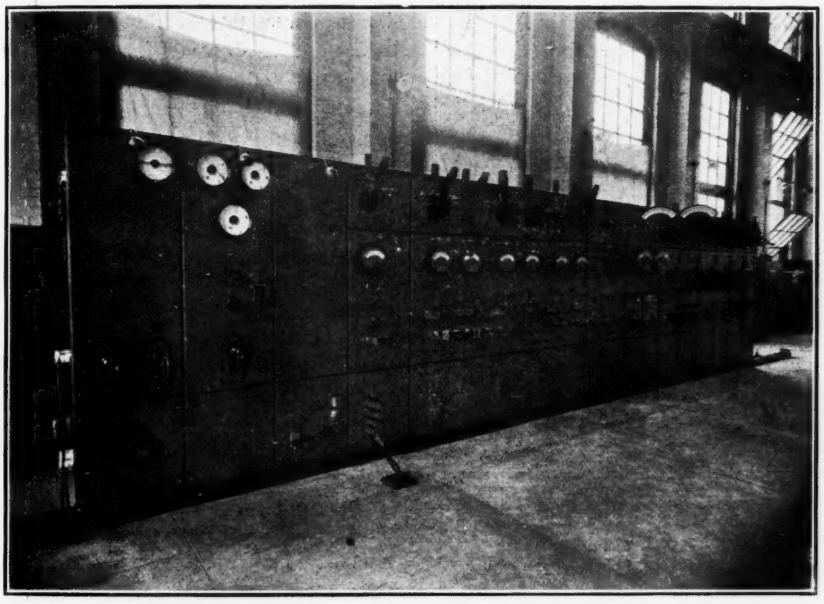


Fig. 2.—Switchboard, Erie Railroad Shops, Hornell, N. Y.

The generating equipment consists of three Ball & Wood cross-compound, high-speed condensing engines, two of 500-horse-power each, direct-connected to a Westinghouse 300-kilowatt, direct-current, 250-volt, three-wire generator, running at 150 revolutions per minute, and one of 400 horse-power, direct-connected to a similar generator of 200 kilowatts capacity operating at 200 revolutions per minute. The engines run condensing except in cold weather, when the exhaust steam is utilized in heating the shops. Water for condensing purposes is stored in a large well, which derives its supply from a small river near the power-house.

Besides the generating equipment and pumps there are two Ingersoll-Sargent compound air-compressors that furnish compressed air to the pneumatic hammers in the shops.

A motor-generator set supplies current for the yard and depot lights. It consists of a 115-horse-power motor, direct-connected to a seventy-five-kilowatt, two-phase, sixty-cycle, 1,040-volt, revolving-field alternator, operating at 900 revolutions per minute.

A standard switchboard, shown in Fig. 2, is provided with motor-generator panels, direct-current generator panels, feeder panels and a load panel, two blank panels providing for future extensions.

There are three motor-generator panels, two alternating-current and one direct-current or motor panel. The alternating-current generator panel is provided with one indicating wattmeter, one ammeter, one voltmeter, one type F oil-switch, a rheostat and the usual smaller instruments. The feeder panel is equipped with one power-factor meter and two type F oil-switches. Mounted upon the motor panel is a circuit-breaker, an ammeter, a field rheostat and a motor-starting switch. The three generator panels are provided with the usual apparatus for a three-wire installation. The load panel is equipped with two switchboard-type integrating wattmeters, two ammeters and two voltmeters.

The six feeder panels control six circuits as follows: circuit No. 1—new erecting shop, 120-ton crane and transfer table;

circuit No. 2—carpenter-shop, blacksmith-shop, new boiler-shop and tank-shop motors; circuit No. 3—roundhouse turntable, machine-shop, coal-pocket and ash-pit motors; circuit No. 4—all line-shaft motors; circuit No. 5—individual-drive motors; circuit No. 6—motors in power-house for coal-conveying apparatus. Each feeder panel is also provided with switches for controlling the various lighting circuits.

Current is transmitted by cables through a large tunnel to the new erecting shop and thence through underground conduits to the various buildings. The three-wire system of distribution is used for lighting and power, with an electromotive force of 250 volts between outside wires and 125 volts between each outside wire and neutral. There is a decided advantage in the flexibility of the voltage, as incandescent and Cooper Hewitt lamps are operated on the 125-volt sides of the system, and constant-speed, 250-volt motors are connected to the main or outside wires while the variable-speed motors utilize shunt-field control. The switchboard and all of the motors referred to below are of Westinghouse design.

The old erecting shop utilizes both group and individual drive, the group-driven machines being divided into five sections and operated by five type S constant-speed motors, two of thirty-horse-power capacity and three of fifty-horse-power capacity. The machines in the fitting shop, which occupies one wing of the erecting shop, are also group driven by a thirty-horse-power, constant-speed, type S motor. A complete list of the machine tools operated in each section is given below:

Section 1—Fifty-horse-power, constant-speed, type S motor—Wheel press, 100 tons capacity; wheel press, 300 tons capacity; car-wheel borer, double car-axle lathe, single car-axle lathe, four-spindle drill, horizontal boring machine, twenty-four-inch engine lathe, eighty-inch driving-wheel lathe, two sixteen-inch engine lathes, eighteen-inch engine lathe, fifteen-inch engine lathe, ten-inch slotter, No. 4 plain milling machine, fifty-three-inch vertical boring mill, forty-two-inch vertical boring mill, thirty-seven-inch vertical boring mill, thirty-six-inch upright drill, twenty-eight-inch upright drill, twenty-four-inch pillar shaper, thirty-two-inch by thirty-two-inch by eight-foot planer, one-and-one-half-inch by twenty-four-inch turret lathe, ninety-inch quartering machine, duplex emery grinder, seven-spindle nut tapper, forty-inch upright drill, small flange punch.

Section 2—Thirty-horse-power, constant-speed, type S motor—Sixty-inch by sixty-inch by nineteen-foot planer, five-foot radial drill, four-foot radial drill, eighteen-inch slotter, two two-inch double bolt cutters, one-and-one-half-inch stay-bolt cutter, twelve-inch slotter, two-spindle centering machine, slab milling machine, forty-inch drilling, facing and tapping machine, duplex emery grinder, triple head slotter, forty-inch upright drill, two sixteen-inch engine lathes, one one-and-one-half-inch bolt pointer.

Section 3—Fifty-horse-power, constant-speed, type S motor—Forty-two-inch by forty-two-inch by eighteen-foot planer, ring turret lathe, forty-eight-inch upright drill, forty-two-inch engine lathe, thirty-inch engine lathe, twenty-four-inch engine lathe, crank planer, twenty-inch by twenty-inch by twenty-four-foot; two-inch by twenty-six-inch turret lathe, thirty-six-inch engine lathe, thirty-six-inch engine lathe, horizontal boring machine, horizontal boring machine, fourteen-inch engine lathe, two sixteen-inch engine lathes, forty-two-inch vertical boring machine, forty-inch upright drill, thirty-two-inch by thirty-two-inch by eight-foot planer, five-inch radial, double-head traverse shaper, No. 4 plain milling machine, twenty-six-inch engine lathe, thirty-inch engine lathe.

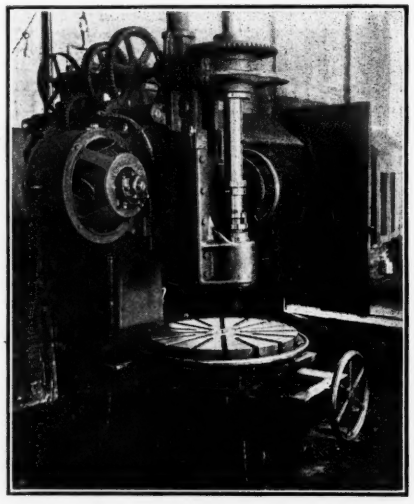


FIG. 3 —SEVEN-AND-ONE-HALF HORSE POWER MOTOR OPERATING VERTICAL MILLER, ERIE RAILROAD SHOPS, HORNELL, N. Y.

Section 4—Fifty-horse-power, constant-speed, type S motor—Sixteen-inch engine lathe, twenty-four-inch engine lathe, twenty-four-inch pillar shaper, friction drill, thirty-six-inch by thirty-six-inch by ten-foot planer, thirty-six-inch by thirty-six-inch by eight-foot planer, thirty-two-inch by thirty-two-inch by eight-foot planer, twenty-inch engine lathe, eighteen-inch engine lathe, sixteen-inch engine lathe, twenty-four-inch engine lathe, cylinder boring machine, No. 17 Landis grinding machine, forty-two-inch vertical boring machine, thirty-six-inch upright drill, twenty-eight-inch upright drill, forty-eight-inch upright drill, thirty-six-inch engine lathe, thirty-inch engine lathe, two Fox turret lathes, eighty-six-inch vertical boring machine, duplex emery grinder.

Section 5—Thirty-horse-power, constant-speed, type S motor—two-inch by twenty-six-inch turret lathe, twenty-inch American brass lathe, twenty-four-inch engine lathe, eighteen-inch slotter, key-slot milling machine, thirty-inch engine lathe (piston rods), thirty-six-inch by thirty-six-inch by ten-foot planer.

Fitting Shop—Thirty-horse-power, constant-speed, type S motor—Twenty-eight-inch upright drill, thirty-ton arbor press, thirty-six-inch by thirty-six-inch by eight-foot planer, thirty-seven-inch vertical boring machine, three eighteen-inch engine lathes, sixteen-inch engine lathe, thirty-inch engine lathe, eleven-inch bench speed lathe, twenty-four-inch pillar shaper, crank planer, twenty-inch by twenty-inch by twenty-four-foot; forty-inch upright drill, fifteen-ton arbor press, two-spindle centering machine, buffing wheel, small emery grinder, surface grinder, guide grinder, polishing tape and wheel, swing grinder, friction drill.

In addition to the group-driven machines in the erecting shop, there are a number of individually driven machines operated by both constant and variable-speed Westinghouse type S motors, as follows:

Constant-speed motor-driven machines—One twenty-horse-power motor driving a planer, one thirteen-horse-power motor direct-connected to 600-ton wheel press, one seven-and-one-half-horse-power motor for moving tail-stock of driving-wheel lathe.

Variable-speed motor-driven machines—One seven-and-one-half-horse-power motor operating vertical miller for side-rods, one twenty-horse-power and one six-horse-power motor operating ninety-inch boring mill, one twenty-horse-power motor operating driving-axle lathe, one seven-and-one-half-horse-power motor operating crank-pin lathe, one forty-horse-power motor operating ninety-inch driving-wheel lathe, one twenty-five-horse-power motor driving truck-tire lathe.

The speed of these motors is controlled by varying the field strength, and, as this may be done while the machine is in opera-

tion, it affords an easy and convenient method of speed regulation always under the immediate control of the operator, the controller being conveniently placed within his reach. The variation of field strength is effected by means of a resistance placed in the shunt-field circuit of the motor, which decreases the shunt-field current and causes a decrease in the field strength and an increase in speed, producing an extremely simple and effective means of varying the speed of either a shunt or a compound-wound motor.

paratus, thus materially reducing the first cost of an installation. The regulation of motors operating by shunt-field control is good, which is of special importance in the operation of machine tools and in service of any class where constant speed is desirable and where the torque varies between wide limits. The efficiency of motors operating at variable speeds remains practically constant over the range of speed.

Having considered the erecting-shop equipment, the smaller shops next receive

reamer and cutter grinder, Gardner disc grinder.

Carpenter Shop — Fifty-horse-power, constant-speed, type S motor—Hollow-chisel mortiser and boring machine, gaining machine, two-spindle shaper, molding machine, twenty-four-inch by fourteen-inch by nine-foot Daniels' planer, plain mortiser and borer, eight-inch by fourteen-inch planer, three cutters; eighteen-inch rip saw, twelve-inch rip saw, forty-two-inch band saw, twelve-inch cutting-off saw, single horizontal borer, tenoning machine,

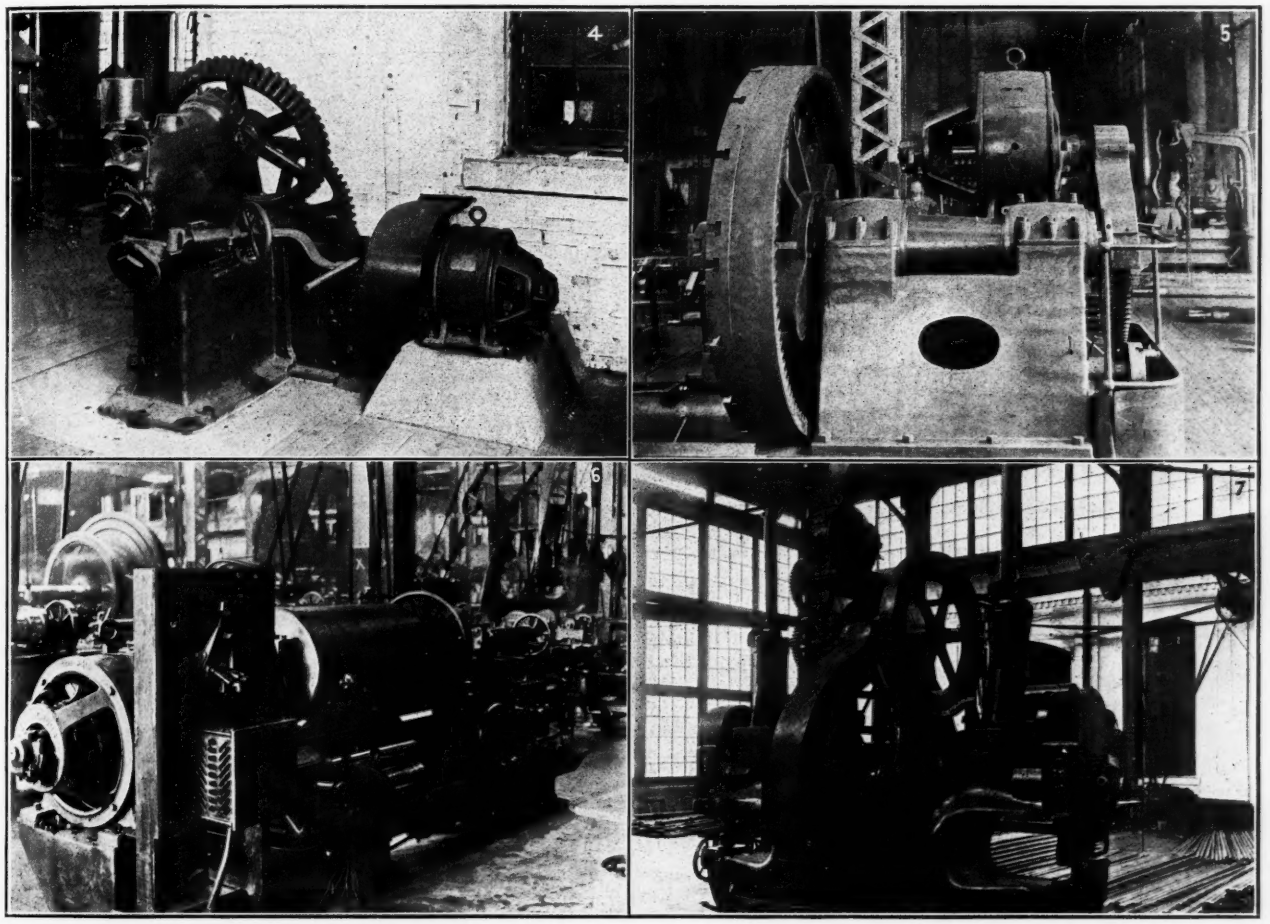


FIG. 4.—SEVEN-AND-ONE-HALF HORSE-POWER MOTOR, OPERATING LENOX BEVEL SHEARS. FIG. 5.—FORTY-HORSE-POWER MOTOR OPERATING NILES DRIVE-WHEEL LATHE. FIG. 6.—SEVEN-AND-ONE-HALF HORSE-POWER MOTOR OPERATING CRANK-PIN LATHE. FIG. 7.—SEVEN-AND-ONE-HALF HORSE-POWER MOTOR OPERATING HILLIS & JONES COMBINED PUNCH AND SHEARS.

One of the most prominent characteristics of this method of control is the simplicity and low cost of control apparatus made possible by the extremely small current which is handled. A second marked characteristic is the increase of speed with decrease of torque, when used as an adjustable-speed motor, the horse-power output remaining practically constant throughout the whole speed range, which makes it peculiarly adapted to machine-tool driving. This system involves the use of a minimum amount of auxiliary apattention, the motors and the machine tools they operate in each department being given in their respective places.

Tool Room—Twenty-horse-power, constant-speed, type S motor—Yankee twist-drill grinder, duplex emery grinder (eight-inch wheels), No. 4 Universal milling machine (Brown & Sharpe), No. 4 Universal milling machine (Cincinnati milling machine), fifteen-inch by fifteen-inch by twenty-foot crank planer, sixteen-inch tool-room lathe, No. 3 Landis universal grinding machine, Sellers tool grinder, fifteen-inch turning lathe, fifteen-inch swing vertical borer, four-inch pipe cutter, three-inch pipe cutter.

Blacksmith Shop—Thirty-horse-power, constant-speed, type S motor—Two power hammers, light-bar shear, small-bolt header, one-and-one-half-inch bolt header, two-and-one-half-inch bolt header, alligator shears, bar-iron shears, hot saw, fifty-horse-power, constant-speed, type S motor direct-connected to fan.

Boiler Shop—Seven-and-one-half-horse-power, constant-speed, type S motor—Two

Hartz flue-welding machines, two flue-cutting machines.

Direct-driven machines operated by constant-speed type S motors—Seven-and-one-half-horse-power motor driving twenty-inch punch and shears, twenty-five-horse-power motor operating plate rolls, ten-horse-power motor operating horizontal punch, seven-and-one-half-horse-power motor driving bevel shears, ten-horse-power motor operating thirty-six-inch punch and shears.

In connection with the boiler-shop equipment there is a flue rattler which is located outside the building and is operated by a twenty-horse-power type S motor. It is forty-eight inches in diameter and twenty-two feet long, and has a capacity of 175-200 flues. An average of five lots per day are cleaned, the exact time for each rattling depending upon the water used in the boilers. The longest flue is twenty-one feet, and they vary from one and one-half to two and one-half inches in diameter.

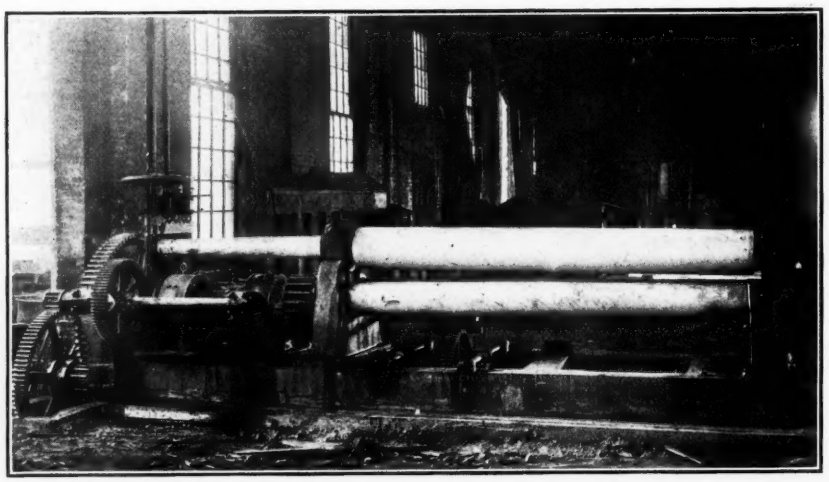


FIG. 8.—TEN-HORSE-POWER AND FIFTEEN-HORSE-POWER MOTORS OPERATING PLATE ROLLS.

Tank Shop—Twenty-horse-power, constant-speed, type S motor—Thirty-six-inch single shear, thirty-six-inch single punch.

In addition to the belt-driven machines there is a ten-horse-power and a fifteen-horse-power, constant-speed, type S motor geared to a plate roll.

Roundhouse Machine Shop—Twenty-horse-power, constant-speed, type S motor—Sixteen-inch engine lathe, twenty-six-inch engine lathe, thirty-two-inch by thirty-two-inch by eight-foot planer, twenty-four-inch pillar shaper, forty-inch upright drill, duplex emery grinder, fifteen-ton arbor press.

Miscellaneous applications—One seventy-horse-power, type S, constant-speed motor driving fan for roundhouse heating system; one ten-horse-power, type S, constant-speed motor driving fan for new erecting-shop heating system; one seven-and-one-half-horse-power, variable-speed, type S motor operating roundhouse turntable; one fifty-horse-power, constant-speed motor operating coal conveyer in locomotive coaling station; one thirty-horse-power, constant-speed, type S motor operating ash conveyer for removing ashes from locomotive ash pit; one seven-and-one-half-horse-power motor operating alligator shears for cutting up sheet scrap (this installation is located at the scrap bins in the shop yards); one twenty-five-horse-power motor operating transfer table.

The preliminary studies and final report, showing the benefits which would be the result of electrically equipping these shops, were made by the Westinghouse Electric and Manufacturing Company in conjunction with the motive power department of the Erie. The results have more than borne out the promises made to the management.

The installation of the new electrical equipment presented many engineering problems, but the work of transformation was carried on without any interruption to the service, and it reflects great credit to the contractors, Westinghouse, Church, Kerr & Company, who installed the plant, and George T. Depue, master mechanic of the Erie Railroad Company, who has charge of the Hornell shops.

The Chicago Electrical Trades Exposition.

It is announced that nearly all the space for the Electrical Show to be held at the Coliseum, Chicago, Ill., in January, 1907, by the Chicago Electrical Trades Exposition Company, aggregating nearly 30,000 square feet, has been sold. So great has been the demand for space that the Coliseum annex will be used for exhibitors. In addition to the exhibitors announced recently, the following firms have signed for space within the last few days: Albert & J. M. Anderson Manufacturing Company, Chicago; Pierce Specialty Company, Chicago; Chicago Compound Battery Company, Chicago; Eureka Electric Company, Genoa, Ill.; Bidwell Electric Company, Chicago; Beck Flaming Lamp Company, New York city; Felix Hamburger, New York city; Dean Electric Company, Elyria, Ohio; American Sewer Pipe Company, Pittsburg, Pa.; American Clock Company, Chicago; Universal Manufacturing Company, Chicago; Shelby Electric Company, Shelby, Ohio; American Instrument Company, Philadelphia.

It has been determined that it will be a physical impossibility to exhibit the Cahill Telharmonium at the coming exposition, but an attempt will be made to give a long-distance test of the telharmonic system. An effort will be made to transmit music from the New York central music station to the Coliseum during the show. The longest test yet made of the system was from Holyoke, Mass., to New Haven, Ct., about 100 miles.

Arrangements have also been made for an installation of the Moore vacuum-tube light.

Non-Resident Lectures at the University of Minnesota.

On Saturday, November 17, F. A. Sager, of the Arnold Company, Chicago, Ill., lectured before the engineering students of the University of Minnesota on "What Is an Engineer-Constructor?" Taking as an example the design and construction of a railroad repair shop, Mr. Sager outlined the steps in analyzing the problem, making preliminary studies of various plans, selecting the best plan, tabulating estimates of cost, making the preliminary report, tabulating and analyzing bids, keeping record of progress and cost of the work, etc. Analogies were shown between the organization of the engineering office and of a football team; electrical, civil, structural, industrial, architectural, sanitary and mechanical engineers corresponding to the line, the purchasing agent as quarter, the constructing and operating engineers as half-backs, and the accountant as full-back. There must be full coordination and cooperation for every part of the team for effective work. In an engineering office loyalty is of the greatest importance, common sense and skill coming next.

On November 22, C. H. Harris, engineer with the Minneapolis General Electric Company, lectured to the engineering students on "The Taylor's Falls Development." Mr. Harris is the resident engineer in charge of the hydroelectric development at Taylor's Falls, which is to furnish 12,000 horse-power at 50,000 volts to Minneapolis, a distance of fifty miles, the ultimate capacity being 24,000 horse-power.

American Institute of Electrical Engineers.

The two hundred and eleventh meeting of the American Institute of Electrical Engineers was held at the Edison Auditorium, New York city, on Friday evening, November 23.

Secretary R. W. Pope announced that fifty-four associates had been elected at the meeting of the Board of Directors held in the afternoon, and further said that on Thursday, November 22, upon the invitation of the trustees of the United Engineering Society, the Boards of Directors of the three founder societies met at the new engineering building at five o'clock, and inspected the new building. The office floors are practically complete and ready for occupation; the auditorium and grand entrance hall on the first floor are yet in the hands of the contractors. Resolutions had been passed at this informal meeting authorizing the trustees of the United Engineering Society to proceed with arrangements for the formal dedication of the building, which will take place in April next. Although the societies will occupy these quarters in the course of a month or two, no formal meetings will be held in the building until after the dedication in April next.

At the same meeting Chairman T. C. Martin, of the Building Fund Committee, announced that Mr. George Westinghouse, as representing the various Westinghouse Companies, had contributed to the land, building and endowment fund the sum of $50,000, to be equally divided between the three founder societies toward the payment of the land. This was followed by the announcement that the Allis-Chalmers Company had contributed the sum of $3,500, to be similarly divided between the three societies. This brings the amount pledged toward the payment of the Institute's proportion for the land to $155,000, out of $180,000, which is to be raised.

Two papers were read and discussed at the meeting. The first was by Dr. C. P. Steinmetz and was entitled "The Transformation of Electrical Energy into Light." Attention was called to the low efficiency of transformation of all types of illuminants. The bearing of temperature upon efficiency, and the phenomena known as selective radiation were described, it being shown how they affect the efficiency. The physiological aspect of the question of efficiency was dwelt upon briefly, it being pointed out that a given amount of energy in the form of green or yellow rays gives more light than the same quantity in the form of red or violet rays. Electro-luminescence was described, and the various types of electric lamp were taken up, including the vacuum tube lamps, making use of the phenomena observed in Geissler tubes, and the arc, both open and enclosed as in the vapor arc. The peculiarities of these discharges were explained, and it was shown that for alternating currents carbon is practically the only available material. For direct-current arcs various materials are available, but the metals of the iron group are particularly desirable, since they give a spectrum closely resembling that of daylight, and since the luminosity of the arc is due to the materials of the negative electrode which are carried into the arc by the current itself. In the so-called flame arcs the incandescent material is produced by volatilization due to the high temperature. The former type of arc, therefore, represents the more direct transformation from electrical energy into light. Moreover, in this lamp the efficiency does not depend on the temperature of the electrodes. The best electrode is one formed of a mixture of magnetite and titanium oxides, the former material furnishing the conducting matter for the arc, and the latter the light-giving part. So far it seems that only the green mercury spectrum, the yellow calcium spectrum and the white titanium spectrum offer an efficiency so vastly superior to that of incandescent solids that, as regards the efficiency of light production, no possible improvement in incandescent lighting can hope to approach it.

The second, entitled "New Types of Incandescent Lamps," by Dr. Clayton H. Sharp, was presented in abstract by the author. It will appear, somewhat condensed, in a later issue.

Diagrams were thrown on the screen and explained by Dr. Sharp, and he also gave a practical demonstration of the characteristics of some of the lamps.

Dr. H. C. Parker emphasized the statement made by Dr. Steinmetz that it is not the melting point of refractory substances that determines the efficiency, but it is the point of disintegration or vaporization. He, associated with W. G. Clark, has been experimenting for a number of years on incandescent lamps. One filament tried, which is supposed to have a melting point of 1,800 degrees, has shown an efficiency in experimental lamps of about one watt per candle, with an average life of 700 to 1,200 hours. It is almost impossible to vaporize this substance. If, therefore, we have substances which at low temperatures of 1,800 to 1,900 degrees will give an efficiency of one watt per candle, and if at the same time we have carbon filaments which are running at 1,800 to 1,900 degrees giving an efficiency of only 3.5 watts per candle, and since the carbon filament at least approximates the black body, we certainly know we have substances which have an immense selective radiation in the solid form. In vapors we have the most intense selective radiation without respect to temperature. This is shown in the experiments in connection with the electrodeless discharge. C. C. Trowbridge found that when the receiver is surrounded by liquid air a very considerable luminescence may be obtained and the luminescence may continue for a number of minutes after the electrical disturbance has been discontinued. He has calculated if the number of molecules in the rare gases could be increased the efficiency would be approximating 100 per cent; that is, we can have luminescence in the gas, practically, that is absolutely independent of temperature.

John W. Howell, calling attention to Dr. Sharp's figures which show that the carbon filament has, in sixteen years, improved 2.5 times in value in life at the same efficiency, yet the tungsten lamp is already at least 300 times as long lived at the same efficiency. This condition means a revolution in the art of incandescent lighting and all lighting. This tungsten filament can be most easily made in rather large candle-powers. Forty candle-power would be about the lower limit at 110 volts. It fits in exactly in the place where the carbon filament is weak. The tungsten filament from forty to 200 candle-power is at its best, and at these candle-powers it is more likely to be the competitor of the arc lamp and other high candle-power lamps. The high temperature of the tungsten lamp is of course a large element in its efficiency. Waidner and Burgess state that a polished platinum wire is the most efficient metallic light-giving body, and as some of the tungsten filaments approach very closely in appearance to polished platinum wire it is probable that these forms will be the most efficient.

Percy H. Thomas showed how prettily the corpuscular theory explains the various phenomena observed in all types of lamps, pointing out that heat radiations are probably due to the motion of the atom as a whole, while visible radiations may be due to the internal motions of the atoms. It seems likely that selective radiation is in

some way due to the large atomic weights of the bodies exhibiting it. High efficiency, while desirable, must be combined with other desirable features, such as intrinsic brilliancy, color, etc.

John W. Lieb said the performance of the sixteen-candle-power, 3.1-watt carbon-filament lamp is not completely satisfactory with alternating currents of twenty-five cycles. It had been hoped that the characteristics of the tungsten filament, its hanging on to the candle-power, even with large changes of voltage, would make it suitable for low-frequency systems. But it seems to be a race between this physical characteristic and the other one of the extreme tenuity of the filament making the lamp, on the other hand, more sensitive to fluctuations of current. We, therefore, at least as far as the experiments to which Dr. Sharp has referred, still have to look forward to some further developments, some further modification, which may solve this problem.

W. G. Clark said that his work with Dr. Parker had lead him to believe that the ordinary carbon filament is not of even temperature, but is made up of very narrow zones or spots of high incandescence, and possibly, in an unflashed filament, of actual arcing in some places. Some metallic filaments which are white in color at low temperature still radiate as black bodies. A great many white metals turn black before they begin to radiate light. Experiments with thorium oxide, oxide of aluminum, flocculent silicon dioxide, calcium oxide and a number of other white oxide-forming materials indicated that they luminesce or become incandescent direct from their own white color to the characteristic light or wave-lengths which they emit without passing through all of the longer wave-lengths leading up to and through the red end of the spectrum. It is possible to make a non-luminous gas flame luminous by charging it with a silicon vapor which gives silicon dioxide upon coming in contact with the air. The oxidization of carbon in the arc produces a gas which would show little if any luminosity, but silicon dioxide becomes luminous at a comparatively low temperature and an open arc from silicon should form the dioxide and become luminous.

The desirability of securing a light which covers the entire range of visible wave-length is brought out by Steinmetz, but instead of endeavoring to secure this entire range in one material or in two similar materials, as in the magnetite-titanium arc, may we not secure an efficient result by combining materials which show high efficiency at each end of the visible spectrum. As an instance, if we were able to combine the mercury vapor arc with a light from a material which showed its highest efficiency in the red end of the spectrum, the resultant light should be both satisfactory and economical. The carbon filament is, of course, not sufficiently efficient when maintained at the temperature where the red rays predominate, but a combination of the Geissler-tube effect with the mercury-vapor arc would be a step in this direction.

W. J. Hammer dwelt briefly on the historical features of incandescent-lamp development and pointed out that one of the difficulties met by the earlier experimenter with metallic filaments was in finding a proper binding material.

De Lodyguine about ten years ago made a number of metallic-filament lamps, some of which lasted several hundred hours. But he did not succeed in making a commercial incandescent lamp in this way, for the reason given.

C. W. Hogan asked whether the better efficiency of the metallized filament was due to its shape. A triangular filament would give a greater radiating surface than a circular one of equal cross-section.

Professor W. S. Franklin said that substances like calcium oxide, when bombarded by cathode rays, give off luminous radiation in great excess over the heat radiations, and it is possible that we may be able to secure a very high efficiency of illumination by making use of that method. Most of us who have been working on the problems of illumination have been too much dominated by the theory of radiation which has grown up with the notion of the ideal black body. We speak of any radiation differing from that as selective. But suppose we cause the body to radiate, not by heating, but by stretching the molecules out and letting them fly back again, a wide departure may be expected from black body. Such effects may be produced by cathode rays, but the phenomenon should not be called selective radiations, but selective excitation. The substance which shows this property to the most striking extent are the oxides of the two didymiums. They have the property of giving almost the whole spectrum in the solid form, especially when excited by cathode bombardment. These substances give the possibility of being selectively excited, and therefore radiating short waves of enormous strength, even though they may be at a low temperature.

Dr. Steinmetz, in closing the discussion, said he had observed the tarnishing of iron when trying to use it in the mercury arc. Even in a very high vacuum, iron when heated will show different colors. Incandescent silicon, while brilliant, is far below the titanium arc. The increased radiating surface of the triangular surface will radiate more light. Unfortunately, it will also radiate in the same proportion more heat rays. The efficiency would be no better than that of the round filament. By having an exhausted glass tube, a Crooke's tube coated inside with tungsten, and exposed to a cathode discharge, gives a beautiful white glow. The only trouble is that the luminescence excited by the cathode ray is excited by an extremely high-velocity bombardment, and the impact not only gives us light, but gives mechanical fracture and destruction, and such a lamp has limited life. The general difficulty in the use of this cathode bombardment is that the action goes further than merely striking the light wave—it goes into mechanical destruction, and therefore the life of such things is very low.

The maximum efficiency of light given by a tungsten filament at the temperature of self-destruction is something like 0.2 of a watt per candle power. That efficiency was obtained long ago by the flaming-carbon lamps. At the same time the arc is a larger size illuminant. The incandescent lamp has the better advantage of giving better distribution of light by smaller units; at the same time the tungsten filament does not have this advantage as much as the carbon filament, because, at least at the voltage of 110, it can not be brought down to the small units as the incandescent lamp. There are some future developments possible in the increased efficiency of the arc lamp, because even an efficiency of one-quarter of a watt per candle power is ridiculously low from the point of view of the efficiency of the electric motor. We might possibly get still higher efficiency than this, but what we want is not light, but illumination, and then the question of distribution comes in. Again, high intrinsic brilliancy is a disadvantage. In that respect the advantage is with the mercury arc and the vacuum tube. In the question of illumination comes the difference in the physiological effect of different colors. Green is a much more efficient color than red, and the same amount of energy put in a green light gives many more candle power than a red light. The light equivalent of energy is a function of the color, but is also a function of the total intensity. A given amount of energy put into a green light

is very many more times effective than the same amount of energy put into a red light when seen at a considerable distance. Where you want to get a low intrinsic brilliancy, as in suburban lighting, the green has great advantage over the reddish yellow. The reverse applies when you go to very high intensity, to glaring light. When the light is used to draw attention for advertising purposes, the reddish yellow is always preferred and is also more pronounced, more glaring than the greenish light. Given lights of different colors, the physiological effects must be considered, as the relative value of the lights is dependent on the different intensity of illumination desired. Irrespective of the absolute efficiency, it may be found that for certain classes of work the mercury lamp is more efficient physiologically than any other illuminant, while for other classes the flaming-carbon arc will hold its field, due to its yellow color. In another case the tungsten lamp will be superior, but we can not speak of absolute relative efficiency of illuminants, because the physiological effect varies with the color and intensity of the illumination.

The meeting was then adjourned.

Magnetograph Records of Earthquakes, with Special Reference to the San Francisco Earthquake.

It has been found by Dr. L. A. Bauer that several times within the last few years earthquakes have occurred in this country which, for some reason or other, were not recorded on the existing seismographs, but were indicated by the records of certain magnetographs. A notable instance was the New England earthquake of March 21, 1904. This was not recorded on the seismographs at Toronto, Canada; Baltimore and Washington, but the magnetograph at Cheltenham, Md., sixteen miles southeast of Washington, gave a distinct record. In the same way a number of earthquakes have been recorded by the magnetograph at Baldwin, Kan. To locate, if possible, the reason for this, a concurrent study of seismograph and magnetograph records, secured during the last few years, has been made. The records secured from the San Francisco earthquake are particularly interesting because of the favorable location of various stations for obtaining results. These were secured at Baldwin, Kan.; Sitka, Alaska; Honolulu and Cheltenham. On the other hand, an equally large earthquake on January 31, the region of which was at sea off the coast of Ecuador, was recorded on the magnetographs of Baldwin, Porto Rico and Cheltenham, but not at Honolulu. This would seem to indicate that the effect can not be entirely mechanical. There is a possibility that an approaching earthquake might, through electric or magnetic effects, give the first indication on magnetographs because of the greater velocity of propagation of such effects than that of the mechanical vibrations. A careful comparison is made of the records available and tables are constructed showing the velocities of the various transverse waves computed along the paths from the region of the earthquake to the observing stations. It is shown that the longitudinal waves, which are the first to arrive at the station, travel with an average velocity of six miles per second; the transverse waves at an average velocity of three and one-half miles; whereas the surface waves travel at a velocity of two and one-half miles per second. The records show that in most cases the magnetograph responds only to the longer surface waves, and not to the preliminary tremors. It seems evident that the magnetograph is giving a record of something not immediately evident from the present seismograph records. The author believes that the effects recorded by the magnetograph are chiefly mechanical ones due to the vibrating motion of the points of support, though there is a possibility of a magnetic effect within a certain prescribed region of the origin of the earthquake. In the case of the San Francisco earthquake it seems evident that the magnetograph records were due simply to a mechanical effect.—*Terrestrial Magnetism and Atmospheric Electricity (Baltimore), September.*

BOOK REVIEWS.

"Elements of Gas Engine Design." Sanford A. Moss. New York. D. Van Nostrand Company. Boards. 198 pages. 3¾ by 6 inches. Supplied by the ELECTRICAL REVIEW at 50 cents.

This book is an attempt to present, in condensed form, the fundamental principles with which the designer of gas engines should be familiar. No effort is made to go into mathematical or constructional details, but the chemical and physical problems involved are clearly discussed. The book is supplemented by a number of valuable tables on the properties of gases.

"American Stationary Engineering." W. E. Crane. New York. The Derry-Collard Company. Cloth. 286 pages. 6 by 8 inches. Illustrated. Supplied by the ELECTRICAL REVIEW at $2.

A book intended for the so-called practical man, written by one who thus classifies himself. He evidently has no very high opinion of what are known as experts—men who like to think that they use their brains rather than their hands. The book will be found to contain a great deal of useful information for the man who must run a boiler room and take care of engines. To such probably the absence of threatening mathematical formulæ will be a recommendation.

Electrical Trades' Association of Chicago.

The eleventh annual meeting of the Electrical Trades' Association of Chicago was convened at the Grand Pacific Hotel, Chicago, Ill., Friday evening, November 16. More than eighty manufacturers and jobbers from the central, southern and western states were in attendance. A dinner preceded the business meeting, which was called to order by the president, Frank S. Beardslee. The reports of the officers of the association showed a remarkable increase in membership and an ever-widening field of efficient service. The board of directors was increased, by an amendment of the by-laws, from five to seven members, and the election resulted as follows:

President—Seymour Guthrie, Kellogg Switchboard and Supply Company; vice-president—William A. Browne, M. B. Austin Company; members of the executive board—Thomas I. Stacey, Electric Appliance Company; Harry R. Parsons, Western Electric Company; Frank S. Beardslee, Beardslee Chandelier Manufacturing Company; S. E. Kennedy, Central Electric Company; Frank M. Pierce, Manhattan Electrical Supply Company. James Wolff, New York Insulated Wire Company, was reelected Chicago member of the board of managers of the National Electrical Trades' Association. Frederic P. Vose was reappointed secretary and treasurer.

After the conclusion of the business session, Thomas G. Grier, of the American Circular Loom Company, acted as toastmaster and a delightful programme followed.

Mr. Grier very generously had supplied each guest with a booklet containing the words of the old melodies that have been popular for two or three generations, and, led by Messrs. Parsons and Pierce, the company sung the songs with much gusto and pleasure. Instrumental music was supplied throughout the evening by Tomasco's orchestra. More than twenty of the gentlemen present responded to the invitation of the toastmaster to speak of their regard for the association, and one and all voiced the sentiment that the association service had become an indispensable adjunct to their business and that the underlying principles of cooperation in the exchange of credit information had resulted in safeguarding their credits, protecting their business from financial loss and engendering a spirit of unity and brotherhood among the jobbers and manufacturers of the trade to an extent undreamed of ten years ago.

REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE

An English Pumping Station.

An English electrically driven pumping station has been installed at Black Hill, England, for the Consett Iron Works, to provide the plant with the necessary water. The works are located on the side of a hill, and below it have been constructed two large reservoirs, each with a capacity of 3,000,000 gallons. The water for the various parts of the plant drains into these reservoirs, and in order to return it to the plant a pumping station has been erected at the reservoirs, in which there are three three-throw pumps driven through ropes by direct-current motors. Power is supplied to the motors from a steam-driven generating plant at the works. It delivers the current to the motors at 500 volts. The generators are driven by steam engines, the boilers being fired by spare gas from the furnaces. The engines are rated at 250 horse-power each, and are direct-connected to twelve-pole, over-compounded generators rated at 370 kilowatts. The length of the overhead line is 900 yards. The motors are rated at 120 horse-power each. Each of the pumps is constructed with three rams having a diameter of eighteen inches and a stroke of twenty-two. At twenty-six revolutions per minute they deliver 1,500 gallons under a head of 300 feet. The motor pulley is placed on an independent shaft attached to the motor shaft through a coupling. This is to provide for easy removal of the motor armatures. The lighting system is supplied from a storage battery at the pump house, which is charged from a motor-generator set.—*Abstracted from the Journal of Electricity, Power and Gas (San Francisco), November* 3.

A New Type of Industrial Condenser.

One of the difficulties in constructing condensers for commercial purposes is that of preventing puncturing of the dielectric. When this consists of glass plates covered with sheets of metal foil the strain on the dielectric near the edge of the metal surface is much greater than that elsewhere, and hence puncture takes place here when the difference of potential be raised to a point which is entirely safe for the other parts of the dielectric. To get around this difficulty in the construction of commercial condensers in which the material is used to the best advantage, Moscicki devised an arrangement in which the dielectric is thicker in the neighborhood of the edge of the metal coating. His first form of condenser consisted of a glass tube closed at one end and contracted at the other, the glass being somewhat thicker at the two ends, so as to interpose here the necessary dielectric thickness. These tubes were silver-plated externally and filled with mercury. This type of design is not altogether suited for industrial purposes, and a modified construction has been evolved which is described here by C. F. Guilbert. In this the tubes have the same shape as in the older design, the upper part being contracted into a neck with thickened walls. The closed end is also thickened. This is silver-plated inside and out, and then copper-plated. Connection is made with the inside coating by means of a plug, and the upper portion of the neck is surrounded by a corrugated porcelain tube which also serves to support the condenser tube. The tube thus held is placed in a blackened brass cylinder filled with oil for cooling and makes connection with the outer coating by means of a collar. The weight of the tube is borne on a rubber ring, so as to reduce the effect of shocks. The tubes thus mounted are grouped together in sets, the interior and exterior coatings being connected together, respectively, and the group is supported on an insulating stand. Condensers constructed in this way may be employed for voltages up to 15,000 or 20,000; in fact, they have been used at 40,000 volts. They vary in length from twenty inches to fifty inches, and the outside diameter is about one and one-half inches. An interesting feature of these condensers is the decrease in the cost per kilovolt-ampere with an increase in the voltage, although the decrease is not directly proportional to the increase in tension. This is due to the larger number of elements required to take care of the increased quantity of charge for lower voltages. The condensers are suitable for producing leading wattless currents for regulating transmission systems, for which purpose they are thought to be superior to over-excited synchronous motors. They may also be used for starting induction motors and for protecting electrical systems against the atmospheric discharges. When used in this way the condensers may be arranged in pairs, a terminal of a condenser being connected to each end of an inductance placed in each transmission line. The free ends of the condensers are then connected together and to the ground. This arrangement provides sufficient static capacity to absorb a rush of current due to an atmospheric discharge. A simpler arrangement consists in using one set of condensers for each inductance, the latter being interposed between the condenser and the apparatus to be protected. A similar arrangement is used for protecting railway motors, a condenser being placed in parallel with the apparatus on the car. They are also suitable for use in radio-telegraphy, for producing X-rays and high-frequency discharges.—*Abstracted from L'Éclairage Électrique (Paris), November* 10.

High-Power Wireless Telegraph Station at Nauen, Germany.

The Gesellschaft für Drahtlose Telegraphie, which uses the Telefunken system, has erected a high-power station at Nauen, near Berlin, Germany. The design of the equipment is the outcome of a long series of experiments and embodies a number of new points. Nauen is about twelve and one-half miles northwest of Berlin. At this point a tower, 100 metres high, has been erected for supporting the antenna. It is a lattice-work triangular structure, the three side girders being formed of riveted sections each eight metres long. They are bolted together and connected to one another by means of diagonal stays, and are carried parallel from the top of the tower to about six metres above the ground. At the foot the three girders join to a cast-steel sphere, which rests on a socket constructed as a sole plate. The pressure is carried through a layer of insulation to the concrete foundation. Steps are provided for mounting the tower, and guys are attached at a platform ninety-six metres from the ground. These guys are formed of a number of round iron stays connected by massive links and led

with considerable sag to points 200 metres from the foot of the tower. They are insulated at top and bottom from the tower and the anchors. On account of the high tension employed, which produces a spark one metre long, the upper insulators are arranged in oil. The antenna spreads itself out from the top in an umbrella shape. It consists of six sections, arranged so that the two opposite sections counterbalance one another, the supporting cables being carried over pulleys. For inspection they are lowered generally in pairs, though a single one may be let down. The umbrella consists of phosphor-bronze cables, which, toward the bottom, branch out at a quarter of their length into two fresh cables. There are in all 162 cables, giving a total surface of 60,000 square metres. The sections are anchored to the ground by means of hemp cords and porcelain insulators. The leads to the station-house are carried from the top of the tower and consist of 154 cables in the form of six grids held together by wooden battens. These leads are not insulated from the tower, so that the latter forms a part of the oscillating system. The earthing consists of 108 iron wires arranged fanwise in the earth, which spread out in the same way as the air end into 324 wires. At the centre they are joined together and are led to the station-house. The source of power at the station is a thirty-six-horse-power steam engine.—*Abstracted from the Electrician (London), November 2.*

Rational Lightning Rods.

It is shown by A. Breydel that when two charged Leyden jars are discharged by bringing their inside and outside coatings, respectively, into contact, that the discharge from the inside coatings is quiet and may take the brush form, while that between the outside coatings is violent and disruptive. It is the latter type of discharge that resembles lightning, and it may be profitably studied in developing a rational system of lightning protection. The form of protection proposed by Franklin is a straight rod pointed at the tip, and this is supposed to protect a circular area the diameter of which is equal to the height of the rod. An improved system was proposed by Melsens, which consists in placing discharging points at all the salient points of the roof, connecting these together by a suitable system of conductors and providing suitable grounds. The system proposed by the author is one in which strips of copper or galvanized iron are carried along the angles of the roof, these strips being provided with small vertical rods of the same material. These bands form a metallic cage bristling with discharge points. They are inexpensive and are thought to give better protection than either of the other two systems. This was shown experimentally by making models of the three systems and bringing over them discharge points from a static machine. A silent discharge always takes place to the third system until the points approach very close to the simple, but longer, rod of the Franklin type. It is, of course, necessary to connect the bands through suitable grounds at the base of the plate, and these connections should be insulated from the building so as to avoid danger of side flashes. The discharge points may be made of galvanized iron wire about one and one-half millimetres in diameter. Soldered joints should be avoided everywhere.—*Abstracted from the Monthly Bulletin of the Société Belge d'Électriciens (Brussels), October.*

The Calculation of Star Resistances.

When an instrument such as a wattmeter or a reverse-current relay is used on one phase of a three-phase system, some form of external resistance is usually provided, so arranged and proportioned that the phase of the current in the shunt coil of the instrument shall, as nearly as possible, coincide with the phase of the main current in the series coil when the power-factor is unity. This resistance is usually arranged in star form, two of the points being connected to two phases of the system, the third connected to the shunt coil of the resistance, the other end of which is connected to the remaining phase of the system. In order that the proper phase relations may be obtained, the resistance of the two independent legs of the star must be equal, and if the junction point is to be a true neutral the resistance of the remaining leg, plus the resistance of the shunt coil of the instrument, must be equal to that of each of the other legs. However, it is not necessary for the junction point to be a true neutral in order that the current of the shunt winding shall be in the correct phase, and a method is here given by Alfred Still of computing the value of the resistance employed in order to obtain the desired relation. It is shown that by employing an unbalanced arrangement there may be less power wasted in heating the resistance. If, for example, the two free resistances are increased, while that in series with the instrument shunt is decreased, the phase of the shunt current remains unaltered, and it may maintain its original value, although the current passing through the circuit formed by the other two resistances is decreased. These simple relations hold only when the inductance of the instrument is negligible, but when this must be reckoned with it is possible, by unbalancing the auxiliary resistance, to bring the shunt current into the proper phase. These solutions are shown diagrammatically and application made to several examples.—*Abstracted from the Electrical Engineer (London), November 9.*

Fracture of Axles Originating in Drilled Holes.

There is an increasing number of railway cars in the United States lighted by electricity generated by a dynamo carried on the car and driven by a belt or chain from a pulley on one of the axles of the car. Although it is generally understood that it is not good practice to drill any hole in the car axle when applying such equipment, it does not appear that the danger of doing so has been recognized. Attention is called here to a recent discussion of this matter by Lucien Alphonse Lagros, who says that it is well known that in many materials a drilled hole will prevent the spreading of a crack, and the extension of a crack in a casting or forging is frequently stopped by this means; but the fact that in some cases a drilled hole will cause the commencement of a crack does not appear to be so generally appreciated. Cracks may be expected to appear in any material subject to alternating stresses at places where there is an abrupt change of section or a notch or groove has been made by a cutting tool in a turned surface. Locomotive engineers have for years past recognized the importance of these details and their influence on the life of both cranked and plain axles. As an example, two fractured street railway car axles were described, the fractures in which occurred through the centre of shallow-drilled holes. The first axle failed while at work after a run of 15,380 miles, and the second after running 13,900 miles. In this case the crack was detected before fracture took place. The diameter of the axle at the fracture was in each case three and one-quarter inches, and the cracks occurred several inches from the key seats and at points where the stress would not be a maximum. The drilled hole was made to receive the point of a set-screw to prevent endwise motion of the chain-wheel. The lesson learned from this accident resulted in the use of pairs of clamped plates gripping the axle and bolted to one another, instead of set-screws. It is urged that where the undesirable practice of drilling holes in axles or shafts has been followed, these parts should be carefully examined to detect any signs of fracture as soon as they appear.—*Abstracted from the American Machinist (New York), November 15.*

Methods of Getting New Business

A DEPARTMENT DEVOTED to the COMMERCIAL DEVELOPMENT of CENTRAL STATIONS

Managers are Invited to Contribute Suggestions for Methods of Increasing the Demand for Electric Service

ORGANIZATION AND CONDUCT OF A NEW-BUSINESS DEPARTMENT SUITABLE FOR CENTRAL STATIONS IN CITIES OF 50,000 POPULATION AND UNDER.[1]

BY JAMES L. WILTSE.

A commercial or business department is a necessity with a central station, or in other words, it is the life blood of the central station. Its value is twofold; first, that it brings the company into close relations with the public, and second, that it increases the business of the company. The importance of this department is recognized by many central station managers, and with great resultant benefits to their companies.

This department is to be organized in a company which has had no separate department to take care of its commercial business. It will have charge of all present and prospective customers of the company, excepting the collection of bills. The principal object is to increase and hold the business of the company.

The first thing in the organization of this department is the selection of a competent head for the department. This is a question of the utmost importance to a central station manager, and great care should be exercised in selecting a man who realizes the importance and responsibility of the position. He should be a man who has had central station experience, and one who realizes the necessity of tactful treatment of those with whom he comes in contact.

The principal duties of the head of the department will be to take entire charge of such department and to look after the company's interests in securing and holding business. He will be responsible for the acts of his solicitors, and it should be his duty to see that all possible efforts are put forth by his men in the direction of following up and securing new business. He also settles questions of rates, guarantees, line extensions, and all the minor matters connected with the wishes and requirements of the public. He should take care of all complaints from customers, and should also be capable of taking complete charge of advertising.

[1] In the prize contest carried on by the Cooperative Electrical Development Association this paper received an honorable mention.

Having secured our contract agent the next important consideration is the selection of solicitors for outside representatives. As to these, two will be sufficient to start with. These men should have had some experience with central station work and have a knowledge of light and power engineering. They should be paid a straight salary. This is more advisable than paying them on a commission basis, as better men can be secured by this method of compensation. Each solicitor should be given a certain territory in which his duty will be to take care of the present customers, and to secure new business. These men are to report at the office once a day, make a report of each call and the results, and issue all necessary orders to the proper departments to make connections, etc., and for care of business secured by them.

The contract agent should have an assistant to take charge of the office, see that the solicitors' work and reports are kept up and take general charge of the details of the office. This man should be capable of taking care of all customers coming into the office.

We have now the organization ready to start the sale of our product. This brings up the question: "How shall we push the sale of electric current?" or, "What method shall we adopt to secure new business?" Here is a large field, and if the company will work all of its branches within reasonable limits the growth of the central station business will surely increase greatly.

There are two channels through which we should go to get business. One is through advertising, the other through the outside representatives or solicitors. Advertising is essential, because it informs the public that you are after business. Advertising for this purpose simply means the educating of the public to the adaptability of electricity to the every-day needs of the office, the factory and the home. Many are diffident regarding its use on account of lack of knowledge. Therefore, an educational campaign is advisable to train and familiarize them with the subject. Advertise freely in the local newspapers, as the majority of the people in the small cities read the local papers.

Another good form is in mailing literature in the form of pamphlets or circulars relating to the many advantages and uses of electricity. Enclose with each a return post-card, so that it can be signed and returned for the purpose of having a representative call. This not only advertises your product, but gives them a "lead." This system of advertising should be checked up, and, where necessary, followed up with more advertising, as well as personal canvass.

As a means of keeping present customers awake to the many uses of electricity, a small paster should be attached to their bills, giving a brief description of the articles you wish to advertise or place before them; such as fans, flat-irons, heating and cooking utensils, etc.

Another good scheme is to erect an attractive electric sign outside of the office. This shows that the company believes in the efficiency of electric signs, and also helps to promote the sign business.

Right here, I might say that an attractive office, fitted up with fixtures, shades, etc., giving ideas regarding illumination, and also an exhibition of electric cooking, heating and other electrical devices, will prove a very good advertisement.

The next and the best method of getting business is through the solicitors. We have two men to start out, and as they have been given such a good lead through the advertising, it is so much easier for them to get business, either through canvassing and answering enquiries or follow-up work on advertising.

With all central stations the peak load is generally in the earlier part of the evening, and it is therefore an important item for the company to secure business which will even up the load. To do this it is necessary for the business department to work on installations such as power and heating.

In order to develop the power business, the solicitor should be familiar with the other forms of power and state their comparative disadvantage. He should also be able to lay out power installations in the most economical way, and see that customers follow suggestions and get the desired results.

Another good way to increase business,

if there are many small users of power who can not afford to lay out the money for a new electric equipment, is to advance the cost of the motor or motors, which can be repaid in monthly instalments. This means revenue for the central station, and should, therefore, be given special attention. The solicitors should keep close watch on all gas engines and when they break down or give trouble get on the ground and talk electric power.

In addition to the power business, there is a newer field for the use of electric current which will also help to even up the load on the company's system. This is electric heating. Of the revenue-producing heating devices, the electric flat-iron has already begun to show results to central station companies which have had the foresight to actively push its use. There are also heating and cooking devices, which, while not great revenue producers, are good advertisers, and help to swell the gross receipts. The best method of increasing this business is to deliver these heating and cooking devices on thirty days' trial, and if same are satisfactory they should be sold at practically cost. With the electric flat-iron it is in most cases advisable to lend the iron to the customer, and the increased current consumption will soon repay the company.

Besides the many advantages of electricity over the other forms of illumination, there is one especially important point to bear in mind in securing this business, and that is, the proper layout of the lights. It is, therefore, needful that the solicitors have a knowledge of illuminating engineering, as in some cases it is only by this method that customers may be secured and satisfied.

The electric sign business should be given attention, and the company should furnish and install signs on the premises of customers free of charge. This method has met with much success in many central stations. The usual form is that customers are required to sign a contract with a minimum charge per month. The company could furnish clock switches for signs where customers desire the sign to burn after the closing hours. It is to their interests to do this, as it not only means increased current consumption, but induces other merchants on the street to make their places attractive by night as well.

The idea is for the central station to work up the matter of proper illumination and get the merchants in the city to make a more liberal use of light, not only during open hours, but after stores are closed for the evening.

In a new department of this kind we must initiate an accurate system of keeping records and following up new business. To do this the solicitors should be provided with a small card index file, in which they should keep a record of all prospective business and see that it is followed up properly. They shall note the date and result of every call. In addition to this, they should make a separate report to the office of every call. Agents should be furnished with blank forms for this purpose. These should be of three kinds, each a different color; one form to be used when a customer's application is secured, another form for prospective business, where customer will consider the use of current, and the other form for holding present business or other miscellaneous reports. After checking these reports in the office they should be filed, excepting reports where people are considering the use of current, which should be filed temporarily and followed up until contract is closed.

This card can be used to keep a complete record of the customer's installation, etc., and any other records necessary can be entered on the other side of the card.

All records of this office should be filed according to location.

Two card catalogues should be kept, one for connected, and the other for disconnected customers.

The solicitors should make out the working orders for the business secured by them. After being checked and recorded in the office, the order should then be approved by the credit department. After it has been properly approved it is forwarded to the installation department to do the work.

The office is to keep a record of all business secured, and this can be done by keeping a report showing each day's business, as follows:

*Address*_____ *Business*_____
*Name*_____
*Application Dated*_____ *Rate*_____ *Solicitor*_____

Order Issued	Installation	Connect or Disconnect	Com leted	Remarks

These sheets can be totaled up each day, and at the end of the month a report can be readily made showing the business secured during the month.

SOLICITOR'S DAILY REPORT

Locatio _____ *Present Form Power*_____
*Name*_____ *Estimated H. P. Required*_____
*Business*_____ *Used for*_____
*Present Lighting*_____ *Will customer consider*_____
Probable Insta'.ation ____ *Remarks*_____
*Wired*_____
*Date*_____ *Checked by*_____ *Solicitor*_____

The above is a form which can be used for this purpose.

All forms to be printed the same, but each form to have a different color.

In this way the solicitor's work can be checked up, and every month a report can be made up of the number of calls, and the amount and kind of business secured by him. A customer's card should be kept as follows:

To operate a department such as outlined here, the cost will be approximately as follows:

	Per Year.
Salary of contract agent	$1,800
Two solicitors, each $18 per week	1,872
One clerk, $12 per week	624
For advertising	2,000
Total	$6,296

REPORT OF BUSINESS SECURED,_____ 1 ___

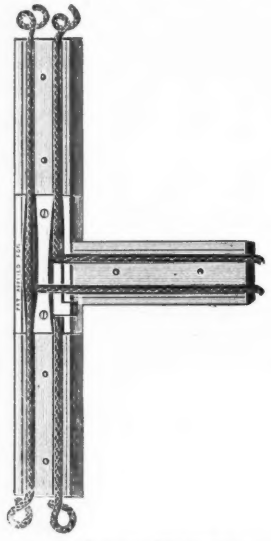
Name	Address	Incs.	Arcs	Power	Misc.	Remarks	Solicitor

INDUSTRIAL SECTION

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS

A New Splice Protector.

The accompanying illustration shows a new splice protector placed on the market by Jordan Brothers, 74 Beekman street, New York city. This splice protector affords a solid, substantial soldered and insulated splice and provides a fire and water-proof porcelain protection at the point where the insulation resistance of the rubber cover on the wire is impaired by the splice. The splice is held in position by the capping of the molding and is practically invisible. The illustration shows the protector in place before the capping has been attached. This does



A New Splice Protector.

away with exposed wires at the point where the splice is made and obviates the possibility of capping nails being driven through the splice. The splice is made for two or three-wire or any combination of branches.

The Apple Ignition System for 1907.

In this period of gas-engine-ignition progress the demand for a better and more reliable method of obtaining all possible power out of the gaseous mixture has called forth many new and meritorious ignition devices.

It is an accepted fact that the ignition factor of gas-engine development has not, with two exceptions, advanced with as rapid a pace as the combustion engine itself. We are, as it were, in a period of ignition unrest—a period reached and passed by gas-engine designers some time ago, to give place to the conservative development of the single type of motor.

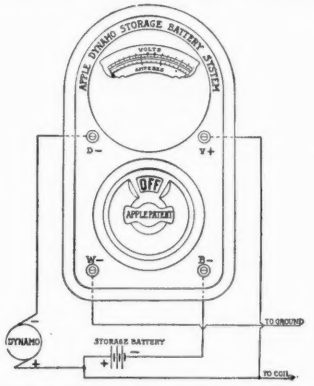
Apple Ignition System—Voltmeter and Four-Way Switch.

The Dayton Electrical Manufacturing Company, Dayton, Ohio, has placed on the market as part of its 1907 system a combination indicating snap-switch, volt ammeter and automatic cutout, assembled in a hard-rubber case, not occupying more than six by three and one-half by three and three-quarters inches of space. A study of this switch and meter panel reveals at once the fact that it enables the operator to obtain complete knowledge and control of his ignition system.

This switch is designed to be used with the Apple battery charger and a storage battery. Not only does it enable the engine user to determine the exact ampere consumption of every coil, but it also enables him to charge his battery at the same rate at which discharge takes place, thus maintaining the battery in a constantly charged and high state of efficiency at all times.

As previously stated a combination volt ammeter is mounted on the front of a small hard-rubber dashboard box directly above a four-way switch. This switch is of the rotary snap type. The switch dial has four indications—"off," "battery volts," "ampere discharge," "ampere charge." When switch is on "battery-volt" position the exact voltage of storage battery may be determined. On this position the car may be run from the storage battery direct. The next position, "ampere discharge," shows the ampere rate at which the current is being consumed by each individual coil, providing the engine is turned to each coil contact respectively or all of the coils when the engine is running. "Ampere-charge" position denotes the rate at which the Apple dynamo is charging the storage battery. By means of an adjustable governor fitted to the dynamo the ampere-charging rate may be varied at will. However, this charging rate, when once "set" by the operator, will remain constant regardless of the speed of the engine. This is due to the operation of the Apple automatic friction governor, whose principles are well known.

To obtain the highest efficiency from an ignition system the battery must be kept in a healthy, fully charged condition. This condition is obtained and maintained by the dynamo, automatic friction governor and switch. Furthermore, on this third position, the position which connects the



Apple Ignition System—Diagram of Connections.

dynamo in parallel with the battery, the dynamo constantly charging the battery and the ignition-current supply being drawn from this battery, an automatic cut-out affixed to the rear of the meter panel is thrown in the circuit. Should the dynamo current fall below the proper consistent charging rate this automatic cut-out severs the connection between the dynamo and storage battery by a positive break of the cut-out armature, and when the proper charging rate is attained connections are again made between dynamo and battery. This cut-out would also work should the engine stop while switch was on third position. There is, therefore, no danger of the battery deteriorating by reason of its current flowing through the dynamo. The fourth

position is the "off" position. All connections are open.

The additional value of a system of this nature, especially at this time of coil consumption agitation, becomes apparent. The well-known Apple dynamo storage battery system furnishes its owner with as much current as he may desire. He is therefore enabled to use coils giving a spark of hotter intensity with a consequent gain of power.

Another innovation in ignition work is the employment by this company of a flexible shaft drive wherever necessary. The company has had this feature in mind for a number of years, and the flexible drive as it is placed on the market is the result of numerous experiments and previous models. The shaft therefore may be looked upon as an assured success. By means of this flexible drive the dynamo may be affixed to the running board or under the seat. It is possible to apply this system much more readily than has previously been the case with some makes of cars. The governor will be fitted with ball bearings. Ball-bearing guides for the flexible shaft will also be provided.

The strides which this company has taken in the last year or so toward the perfection of its system of ignition have been augmented by the addition of these three new features for 1907, the flexible drive, the adjustable governor and the combination switch and meter panel.

DIESEL ENGINES FOR INTERURBAN RAILWAY SERVICE.

BY NORMAN McCARTY.

The records of the Diesel oil engine in this country and abroad have demonstrated—

1—The consumption of fuel per brake-horse-power in the smallest engine is not fifteen per cent greater than that of the largest units, and in every case is within the builders' guarantee of twelve and one-half gallons of oil for each 100 kilowatt-hours delivered at the switchboard under the operating conditions of the system as proposed in this article. The actual fuel consumption of a 225-brake-horse-power unit at full load is ten and one-fourth gallons for each 100 kilowatt-hours, with a generator efficiency of ninety per cent.

2—That the consumption of fuel per brake-horse-power is practically constant from half-load to the rated capacity of the engine.

With the above facts established as they have been by the records of many plants in actual operation there should be no objection to the installation of Diesel oil engines for interurban railway operation, in so far as relates to fuel economy. It is also safe to assume that the actual labor required to operate a number of Diesel primary stations will be less than that required for a central steam station together with that needed for the necessary transformer stations.

The only objection to be raised would refer to the continuity of service, the extreme variation in the load and small overload capacity of the internal combustion engines. The installation of a small storage battery in each station meets these objections and the desirability of the installation of Diesel engines and low-tension direct current as a substitute for steam equipment and high-tension current, either with transformers or single-phase motors, becomes merely a question of first cost and future operating economy. The following is offered as a close estimate of the comparative cost for the installation and operation of a fifty-mile road, with five fifty-ton cars operating at thirty miles an hour on one-hour headway for eighteen hours:

There would be four power stations, each with the following equipment: one 150-kilowatt direct-current, 650-volt unit; one 240-ampere-hour storage battery.

The four engines would deliver 600 kilowatts, and sixteen hours of actual operation at full load would be sufficient for engine service, making a total output of 9,600 kilowatt-hours per day.

The storage batteries would operate the road for the balance of the day, including owl cars and light and power for car barns when the engines were idle.

The total fuel oil required would be 96 × 12½ = 1,200 gallons, which at three cents would make $36, the fuel cost.

The labor required for operating the four stations would be as follows, divided into two shifts of ten hours each:

One chief engineer and electrician	$ 5
Eight assistants at $3 per day	24
Total cost for labor per day	$29

Supplies (lubrication and waste), $1.50 per day for each station, or for four stations, $6.00 per day, making the operating expense:

Fuel	$36
Labor	29
Supplies	6
Total	$71

The cost per kilowatt-hour (fuel, labor and supplies) would then be 7.4 mills.

The Diesel station would deliver to the low-tension feeders all of the current generated while the steam plant, operating through high-tension lines with transformers and rotaries, would probably not do better than sixty-five per cent, so that a steam plant must deliver current on the switchboard at the central power-house at not to exceed five mills per kilowatt for fuel, labor and supplies to equal the economy of the Diesel engine for current delivered to the low-tension feeders.

As the amount of low-tension copper would be exactly the same regardless of the system installed, this cost can be eliminated from the comparison of the two systems, so also the cost of the track and bonding.

The cost of each rotary station building would about equal the cost of building for each Diesel station and we have only to compare the cost of the steam plant, electrical equipment and building, plus the high-tension line and transformer station equipments, against the cost of the Diesel engines, with generators and storage batteries as follows:

Each Diesel station consisting of one 225-brake-horse-power engine, one 150-kilowatt, direct-current generator and switchboard, one 240-ampere-hour battery, which could be completely installed, including foundation, for $35,000; or four stations for $140,000.

A steam-driven plant for a road of this character, however, would install in the power-house two 600-kilowatt units, one of which would act as a reserve under usual operating conditions. Each substation would in all probability be equipped with two 300-kilowatt rotaries, with step-down transformers and devices necessary for their operation, one of the 300-kilowatt units being relied on as a reserve capacity.

A fair average cost of this equipment using rotary substations would be about as follows:

A 1,200-kilowatt steam station including engines, boilers, stack, generators, step-up transformers, switchboard and auxiliaries, at $95 per kilowatt, completely installed	$114,000
Building foundations	15,000
Fifty miles of three-phase, high-tension line, at $650 per mile	32,500
Four transformer stations, equipment complete	64,000
	$225,500
Showing a saving in first cost for the Diesel system of	$85,500

The installation of the storage battery in connection with the Diesel engine would eliminate any necessity for reserve generating apparatus, as the combined capacity of the generating equipment and storage reserve in each station would be equal to the demand for intervals long enough to meet extreme operating conditions or peak loads.

The items of interest and depreciation

(repairs) are in favor of the Diesel installations, as the first cost is less than that of a high-tension system, consequently less interest charges, and even, if we assume that the repairs on the Diesel engines are equal to the combined repairs of steam engine and boiler installations, the expense of maintaining the high-tension line and transformer stations would greatly exceed the expense of maintaining the storage batteries connected with the Diesel system.

The above statement, as presented, is exceedingly conservative, and probably more favorable to a steam-driven, high-tension system than the average figures for actual operation on a system of this size would show.

Perhaps the strongest argument to be presented in favor of the system proposed next to its simplicity and operating economy is the advantage of being able to build for present needs without in any way affecting the economy, reliability, or flexibility of the line as the future extensions become necessary or additional service added to existing lines. Each section having its own power-equipment, additional sections can be added from time to time, and equipped as though they were separate properties, while additional engine units can be added to each station as the service develops and demand for power increases. The investment can be limited to the immediate necessities without any thought as to future extensions or heavier traffic, with the advantage of decreased interest charges and a much higher operating economy because the generating units installed are always properly proportioned to the service as it exists at that time.

Blue-Print Washing Machine.

A machine devised for washing long rolls of blue-print paper printed by one of the continuous systems is being used in England. The full value of the continuous printing system can not be enjoyed if it afterwards becomes necessary to develop and wash the paper sheet by sheet. In the present machine, which is described in *Engineering* (London) for November 9, the roll of paper, after having been printed, is passed through the washing solution by means of rubber rolls driven by a small motor. A wash spray is provided for use when necessary. From the washing tank the paper passes through rubber-coated rolls which express most of the water, and then is carried through a drying oven, from which it emerges finished and dried. The oven is heated either by steam, gas or electricity.

FIRE-PROOF INSULATED MAGNET WIRE.

BY W. H. EASTON.

One of the striking tendencies of modern engineering practice is the growing demand for indestructible materials. Steel and concrete buildings, all-steel cars, fireproof theatre furnishings, etc., demonstrate the desire to obtain structures that resist those forces that combine for their destruction. The growing use of fire-proof magnet wire illustrates this tendency especially well, and it is gradually eliminating from electrical machinery the weak point, *i. e.*, inflammable insulation.

It has been the great misfortune of electrical development that the great majority of substances used for insulation are incapable of resisting heat. In view of the fact that electrical energy always produces heat, this almost rises to a positive engineering error. Cotton has been the standard insulation for magnet wire, but the use of cotton as an insulator is very much like the use of a metal with a low melting point (such as Wood's or Rose's metal) for a conductor. For, while admirable in every other of its properties, cotton is unfortunately incapable of resisting continuously a temperature of much above the boiling point of water. Burnt-out arc lamp and armature coils and roasted fields are a common occurrence and are responsible for a tremendous economic loss.

The problem of heat-resisting wire has been the study of half a century, and has been solved in various ways with more or less success. Asbestos has been, of course, the basis for the insulation of every wire of the class mentioned, and for many years inventors have been trying various methods of applying asbestos paper or twine to wire. The paper or twine has held upon the wire in most cases, either with cotton thread or a heavy coating of organic paint. In either case the strength of the whole is not more than the strength of the weakest part.

The Heany fire-proof insulated magnet wire is the last form to be produced. It differs from all previous attempts inasmuch as the asbestos is used in the fibrous condition without being worked into twine or paper. The fibres of asbestos are applied in a filmy condition to the conductor and are then saturated with an inorganic cement which forms a homogeneous, durable, flexible, uniform covering, in the nature of a paint which can be built up from a thickness equivalent to a single wrap of cotton to any desired diameter. The result of this structure is to produce an insulation that can not be destroyed by heat, no matter of what degree. There is nothing in it that can burn or decompose (except a very slight amount of gluey matter used to make the filmy insulation adhere temporarily to the wire), and coils may be obtained by the use of this wire that are practically indestructible, except be lightning or mechanical injury. In fact, coils can be made red hot without short-circuiting. This has frequently occurred in practice in the case of arc-lamp coils.

A study of the destruction of cotton-wound coils shows that they usually burn out in one of three ways:

1. By lightning. No insulation suitable for magnet wire will withstand this.

2. By being suddenly overloaded so that the temperature of the conductor rises beyond the carbonizing point of cotton. This is not apt to happen in carefully designed and properly used apparatus, but accidents do happen occasionally. The use of fire-proof insulated wire prevents destruction unless the temperature is so high as to fuse the conductor. Proper fuses should prevent the latter catastrophe, but they are often powerless to prevent a sudden rush of current that will burn out cotton, until after the damage is done.

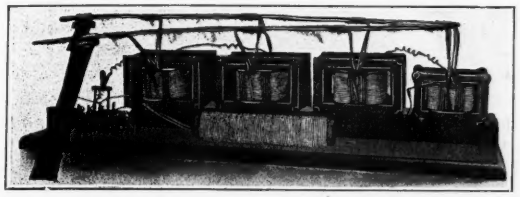
3. By a gradual carbonizing of the cotton, rendering it friable and conducting. This is the usual course of events and it is the final fate of every cotton-wound machine, unless a very large factor of safety is allowed or mechanical injury gets at it first. The heat invariably produced while a machine is in use gradually drives out the moisture in the cotton, causing it to lose its strength. A continuation of the elevated temperature (and practically every electrical machine runs fairly hot) roasts the cotton and carbonizes it. Either the cotton finally becomes a conductor and short-circuits, or it falls to powder, allowing the adjacent conductors to touch—the result is the same in either case.

With fire-proof insulation the gradual roasting is entirely obviated. The continued temperature of 200 to 300 degrees Fahrenheit has absolutely no effect on the insulation, and in consequence coils have an almost indefinite life instead of from six months to a year, which seems to be the average life of a street-railway field coil. This gradual roasting is the fate of any insulation that contains a large percentage of organic matter, whether it also contains asbestos or not.

All heavy-service apparatus, such as rolling-mill, traction and crane motors, arc lamps, lifting magnets, transformers,

blow-out coils, etc., are in constant danger of burnouts, and it is in these forms of apparatus that the fire-proof wire is being most extensively used.

The breakdown point of the insulation 0.010 inch thick is about 600 volts. Its ohmic resistance is equivalent to cotton of similar thickness and under similar atmospheric conditions, when cold. At elevated temperatures, fire-proof insulation has a much greater ohmic resistance, however, and it is probable at operating temperatures a motor wound with fire-proof insulated wire would be more efficient than one wound with cotton.



Bank of Transformers Wound with Fire-Proof Wire.

The accompanying illustration shows a bank of indestructible transformers with a regulating reactance coil. These transformers are used to heat-resistance furnaces and take 110 or 220 volts at the primaries and deliver eleven or twenty-two volts at the secondaries. They can be overloaded indefinitely if it is required. They are wound with the Heany fire-proof insulated magnet wire, and are made up with mica, asbestos tape and twine.

Two Thousand Six Hundred Dollars in Prizes for an Electrical Solicitor's Handbook.

The Cooperative Electrical Development Association, Cleveland, Ohio, announces an offer of $2,600 in prizes for an electrical solicitor's handbook. It will be remembered that earlier in the year the Cooperative Electrical Development Association awarded $1,000 in prizes for papers on the subject of the organization and conduct of a new-business department suitable for central stations in cities of 50,000 population and under. The prize winners were announced at the Atlantic City (N. J.) convention of the National Electric Light Association, the committee which sat in judgment upon the papers being appointed by President Blood, of the National Electric Light Association. Through the cooperation of the technical press and also by means of distribution in pamphlet form, these papers have received widespread publicity.

The present prize offer is the result of the joint action of the Cooperative Electrical Development Association and a cooperating committee of the National Electric Light Association. It is hoped by this means to secure contributions from managers of new-business departments and solicitors, which may be compiled into a handbook for use by central station men generally. The contributions will be divided into three classes, and the prizes will be awarded as follows:

One thousand dollars for the "Light" section, of which $500 will be awarded as the first prize, $300 as the second prize, and $200 as the third prize.

One thousand dollars for the "Power" section, of which $500 will be awarded as the first prize, $300 as the second prize, and $200 as the third prize.

Six hundred dollars for the "Heat" section, of which $300 will be awarded as the first prize, $200 as the second prize, and $100 as the third prize.

A pamphlet is in course of preparation, which will contain general suggestions for the benefit of those who will compete for these prizes. This pamphlet will be sent to any one interested upon request.

A committee appointed by the National Electric Light Association will sit in judgment upon the contributions, and its decision, which will be arrived at just before the next convention of the National Electric Light Association, will be announced at the convention.

The winning contributions, or a combination of winning contributions, will be utilized in such a manner as to confer the greatest benefit to the electrical business along lines which will be determined by the joint committee at some future time.

This offer affords an opportunity for the man connected with the commercial development of central station practice to make a valuable contribution to the literature of the subject, to increase his prestige and establish his reputation, and at the same time to secure a pecuniary reward commensurate with the effort made.

Automatic Electric Motor-Driven Pumping Plant.

A successful induction motor-driven pumping plant for supplying railroad water tanks is in operation on the Lake Shore & Michigan Southern, at South Bend, Ind., is described in the *Railroad Gazette* for November 23. The pumping outfit consists of two Worthington single-stage turbine pumps, each direct-connected to a six-pole, seven-and-one-half horse-power, three-phase, 440-volt General Electric Company induction motor. Two pumping sets are installed, so that in case one set fails, repairs can be made without shutting down the plant. Power for operating the induction motors is taken from the lines of the St. Joseph & Elkhart Power Company.

The pumping house is a round brick structure, erected at the top of a concrete-lined wall. The floor is of concrete, supported by I-beams, and is ten feet below the level of the ground. On this the pumps are erected, and for keeping the pump room dry, four ventilating ducts are built into the wall of the pump house, the outlets appearing in the pilasters in the exterior view.

Each pump discharges water through a two and one-half-inch pipe, connecting with a four-inch main which leads to the supply tank. This tank is located at the side of the tracks about 100 feet from the pumping station. The controlling device is arranged in the housing on the roof, the motors being started and stopped automatically by a small oil-switch operated by a float which has a vertical movement of about one foot. The difference in level in the tank corresponds to 3,000 gallons of water. This is the average amount taken by a locomotive, and is replenished by the pumping set in about twenty-five minutes. The supply tank holds about 50,000 gallons and could supply fifteen locomotives within a few minutes if necessary. However, such a heavy demand will probably never be made, and in actual practice the pumps stand idle for the greater part of the time.

To Harness Victoria Falls.

A despatch to the New York *Sun* from Berlin states that the long-discussed scheme of harnessing the Victoria Falls of the Zambesi river will be begun immediately with united British and German capital. When the works are completed, electric power will be supplied to the industries of Rhodesia and the Transvaal, including the Rand. Probably many railways will be electrified later on, getting their power from the same source.

The Kaiser is greatly interested in the undertaking. He has sent a message to the London branch of the syndicate expressing great pleasure to find serious Britons and Germans cooperating in such an enterprise because it furthers the cause of international peace, which he has so much at heart. The British have the predominating interest in the scheme and will control it.

Current Electrical News

DOMESTIC AND EXPORT.

SAO PAULO TRAMWAY—At a special meeting of the stockholders of the Sao Paulo (Brazil) Tramway, Light and Power Company, Limited, held recently, the propositions to increase the capital stock of the company from $7,500,000 to $8,500,000 and to increase the directorate from nine to ten members were ratified.

NEW POWER SYNDICATE—It is announced that Buffalo (N. Y.) capitalists have formed a syndicate to take over the charter granted in 1893 to the Economic Power and Construction Company. This gives the company very broad powers in regard to the securing of property for its purposes. The capital of the syndicate is stated to be $2,500,000.

TO INCREASE CAPITAL STOCK—The New York & Port Chester Railroad Company has applied to the state railroad commission for authority to increase its capital stock from $250,000 to $20,000,000 and for permission to issue a mortgage for $20,000,000 toward the expense of building the road. President W. P. C. Gotshall testified that the road's construction will cost $40,000,000. The commissioners took the matter under advisement until December 11.

NEW HAVEN ROAD BUYS TROLLEY LINES—The New York, New Haven & Hartford road has acquired the Ray system of street railways, including seventy miles of electric lines in northern Rhode Island and southern Massachusetts. The terms were not given out. The lines included are the Woonsocket Street Railway Company, paid-in capital, $300,000; the Milford, Attleboro & Woonsocket Street Railway Company, $318,000; the Columbian Street Railway Company, $100,000, and the Providence & Burrillville Street Railway Company, $417,000. The New Haven now controls practically all the street railways between Providence and Worcester.

WIRELESS CONSOLIDATION DENIED—The announcement made last week of the consolidation of the interests of the Marconi and De Forest Wireless Telegraph Companies into the United Wireless Telegraph Company, organized with a capital of $20,000,000 under the laws of Maine by Abraham White, president of the American De Forest Company and others, is denied by John W. Griggs, president of the Marconi Wireless Telegraph Company of America. Mr. Griggs states that the United Wireless Telegraph Company has not secured fifty-one per cent of the Marconi company's stock, and that the Marconi officials are not interested in any way in the United company. It is also said that the London Marconi Company has no information concerning the merger and does not consider such possible.

THE NEW YORK & NEW JERSEY RAILROAD COMPANY announces that the tunnels which it is building from Morton street, Manhattan, to a point contiguous to the Lackawanna railroad station, Hoboken, N. J., will be in operation by about July 1, 1907. The company is not going to wait until the extensions of the old Morton street tunnel route are built before running cars through the tunnel. The contract for furnishing the tunnel with an electrical equipment was awarded a month ago, and the proposed power plant to be erected in Washington street, between Jersey City and Hoboken, as well as three substations, will be built early next summer. It is possible that by July 1 the Sixth avenue (Manhattan) extension will be built up to Fourteenth street and that the Astor place extension will also be ready for use. The company's terminal station is to be at Sixth avenue and Thirty-third street.

PLANS FOR UNION OF CHICAGO EDISON AND CHICAGO SUBWAY COMPANIES—Plans for the union of the Chicago Edison Company with the Chicago Subway have been changed, so that instead of a guarantee of dividends reaching nine per cent, the Chicago Subway, through a sub-company, will issue $27,000,000 four and one-half per cent fifty-year bonds for the $13,500,000 share capital of the Chicago Edison Company. This will guarantee the nine per cent dividends of the Chicago Edison Company. The stock will be placed under the collateral trust four and one-half per cent bonds. It is estimated that the development of the Chicago Edison Company will require $15,000,000 in the next five years, which the Chicago Subway must furnish in one way or another. To cover these requirements and the financing of the subway a blanket mortgage of $100,000,000 is under consideration. It is stated that eighty per cent of the Chicago Edison Company shareholders have signified directly and indirectly their assent to the sale of their stock to the Chicago Subway.

EXTENSIVE UNDERGROUND TELEPHONE SYSTEM—The Delaware & Atlantic Telegraph and Telephone Company has completed its conduit system between Wilmington, Del., and Philadelphia, Pa., and it is now in use, the overhead wires having been abandoned so far as the trunk lines are concerned. Some of the pole lines will be retained for use as branch lines, for the convenience of settlements and subscribers along the route, but all of the through wires are now under ground. The underground system between Philadelphia and New York, built by the Bell Telephone Company, with which the Delaware & Atlantic is affiliated, is also finished and in use. The company is now planning an underground system between Wilmington and Washington, and has men at work making the survey, and the company will, in all probability, construct the line next year. It will employ the same method as that used in building the Philadelphia line, beginning operations at several points simultaneously and have the men work toward each other. When this work is completed the Bell Telephone Company and the Delaware & Atlantic Telegraph and Telephone Company will have a complete underground system between the national capital and New York city. When the tunnels under the North and East rivers are completed the cables will be run under the rivers, giving connection with all of the boroughs of New York city.

RAPID TRANSIT LINE FROM BUFFALO, N. Y., TO NIAGARA FALLS—A certificate of necessity has been issued by the state railroad commission to the Frontier Electric Railroad,which is to be a new line of the International Railway Company, running over its own right of way from Buffalo to Niagara Falls. Engineer Ricker, of the International Railway Company, testified before the commission that the construction of the new line would cost, exclusive of terminals, about $2,300,000. The road will run over a route similar to the one now used by the company's Niagara Falls line, about half a mile to the eastward. President Henry J. Pierce, of the International Railway Company, states: "It is the company's plan to build and operate the best appointed and the fastest suburban electric railway in America. The schedule will call for a forty-five-minute run. The cars will be of the most improved type and the roadbed will be the best that the engineers can lay. Work will begin early next summer, and the road will be in operation late next fall. The old line to the falls will be continued as at present. The traffic on the falls line has grown so rapidly, and has reached such proportions, that at times there has been great difficulty in handling the crowds. More people come to the falls every year, and the trolley route from Buffalo is growing in popularity. The company has become convinced that in the near future its present service will be entirely inadequate, and the new line will be built to meet the demands of the increasing traffic."

NEW PUBLICATION.

A NUMERICAL LIST OF PUBLICATIONS IN FORCE—The Allis-Chalmers Company, Milwaukee, Wis., has published a numerical list of publications in force October 1, 1906. This includes matter descriptive of electrical machinery, flour-mill machinery, mining and crushing machinery, power machinery, pumping machinery and saw-mill machinery. Within the past fifteen or sixteen months the company has covered with new bulletins about eighty per cent of its products. This has taken nearly eighty publications, averaging about twenty-four pages. When the list of bulletins is completed the number will be considerably in excess of 100.

PERSONAL MENTION.

MR. LE ROY CLARK has been elected president of the National Steel and Wire Company, succeeding Mr. Everett B. Webster, who resigned some time ago. Mr. Clark is also president of the Safety Insulated Wire and Cable Company, a subsidiary concern of the National company.

MR. EVERETT W. BURDETT, a well-known lawyer representing several of the largest electrical firms in Massachusetts, addressed the Lowell (Mass.) section of the American Institute of Electrical Engineers recently on the subject, "Public or Private Ownership of Public Utilities—Which is Preferable?"

MR. ROBERT McF. DOBLE, of Colorado Springs, Col., formerly of San Francisco, Cal., has been retained as consulting and supervising engineer by Messrs. Curtis & Hine, general managers of the recently organized Central Colorado Power Company, in the development of their large hydroelectric power projects on the Grand river, Col.

MR. CHARLES M. JACOBS, consulting engineer of the Pennsylvania, New York & Long Island Railroad Company, and who as such planned and has had charge of the work of the Pennsylvania Railroad tunnels under the North and East rivers and Manhattan, has been retained by the French government in the undertaking of building a tunnel under the River Seine, from Rouen to Havre. Mr. Jacobs has prepared plans for the work and presented them to the government officials. Mr. Jacobs built the Ravenswood gas tunnel, the first one under the East river, and the four tubes under the North river, two for the Pennsylvania Railroad and two for the Hudson Tunnel Company, from Jersey City to Christopher street, Manhattan, and the work is three-fourths completed on two tunnels being built from the Pennsylvania Railroad station, in Jersey City, to Chambers street, Manhattan.

OBITUARY NOTES.

MR. DANIEL J. LUDWIG died on November 14 at his home in Brooklyn, N. Y. He was born in Watsontown, Pa., sixty-four years ago and served in the Civil War as a government telegrapher. Later he became superintendent of the commercial news department of the Western Union in New York city, afterward entering the service of the Baltimore & Ohio Telegraph Company. He subsequently became superintendent of the Equitable Manufacturing and Electric Company, and at the time of his death was in charge of the Brooklyn office of the Stock Quotation Telegraph Company. The widow and two sons survive him.

COLONEL WILLIAM H. REYNOLDS, well known in financial circles of New York city, Paris and London as a promoter, died at his home, 42 West Ninety-third street, New York city, November 9, after an illness of four weeks. The cause of death was pneumonia. He was born in Providence, R. I., in 1827. At the outbreak of the Civil War he joined the First Rhode Island Infantry, of which he became the commander, displaying high qualities as a leader. At the close of the war he became a cotton broker in New York. When the Bell Telephone Company determined to introduce its system abroad Colonel Reynolds was selected to be the representative, and spent about a year in England and on the Continent in the interest of the company.

ELECTRICAL SECURITIES.

While the stock market was extremely irregular during the past week, the general tendency was upward, with considerable net gains at closing. Monetary conditions continue to be a dominant factor in the market's influence, but there has been a considerable easing in rates. An interesting incident in electrical securities was the recent announcement of an increase in the stock of the General Electric Company from $60,000,000 to $80,000,000. The good showing made by the Interborough-Metropolitan, and the nearness to completion of several of the tunnel roads joining Manhattan with Long Island and New Jersey, centre attention on these industrials. It is said that the prosperity of electrical manufacturers at the present time is unprecedented, and the indications are that this condition will continue for some time.

ELECTRICAL SECURITIES FOR THE WEEK ENDING NOVEMBER 24.

New York:	*Closing.*
Allis-Chalmers common	17½
Allis-Chalmers preferred	44½
Brooklyn Rapid Transit	79⅛
Consolidated Gas	138½
General Electric	175
Interborough-Metropolitan common	36½
Interborough-Metropolitan preferred	76½
Kings County Electric	150
Mackay Companies (Postal Telegraph and Cables) common	73
Mackay Companies (Postal Telegraph and Cables) preferred	69
Manhattan Elevated	143
Metropolitan Street Railway	106
New York & New Jersey Telephone	126
Western Union	85¼
Westinghouse Manufacturing Company	151

The stockholders of the General Electric Company, at a special meeting held at Schenectady, N. Y., on November 20, voted to increase the capital stock of the company from $60,000,000 to $80,000,000. The stock represented at the meeting amounted to about 420,000 shares.

During the year ended June 30, 1906, the Brooklyn Rapid Transit Company expended $8,414,135 for construction and betterments. During the previous year it expended $5,596,811 for the same purposes. During the last fiscal year the combined operating expenses of the system amounted to $10,441,377, against gross earnings of $18,473,328. The operating expenses for the previous year amounted to $9,803,870, against gross earnings of $16,333,444. The percentage of operating expenses to gross in 1906 was 56.52, as compared with 60.02 in 1905. The increase in gross in 1906 was equal to 13.1 per cent, against an increase equal to 6.5 per cent in operating expenses.

The annual meeting of the Metropolitan Securities Company will be held at the office of the company, 621 Broadway, New York city, on December 12. For the purposes of this meeting the transfer books closed on November 27 and will reopen on December 13.

At the special meeting of the stockholders of the Western Union Telegraph Company, the directors, or executive committee, were authorized to sell at any time, in their discretion, part or the whole of $25,000,000 four per cent gold bonds maturing November 1, 1936.

Boston:	*Closing.*
American Telephone and Telegraph	136
Edison Electric Illuminating	230
Massachusetts Electric	69
New England Telephone	129
Western Telephone and Telegraph preferred	80

The American Telephone and Telegraph Company's instrument output for October is as follows: gross output, 174,107; returned, 74,382; leaving net of 99,725. Since January 1 the gross output has been 1,680,296, and the returned 555,707, leaving a net output of 1,124,579. The total now outstanding is 6,922,562.

Stockholders of the Edison Company, of Boston, at a special meeting, voted to authorize the directors to petition the gas commissioners for authority to issue 24,200 additional shares of stock.

Philadelphia:	*Closing.*
Electric Company of America	12⅛
Electric Storage Battery common	69¾
Electric Storage Battery preferred	69¾
Philadelphia Electric	8⅜
Philadelphia Rapid Transit	22¾
United Gas Improvement	97¾

Chicago:	*Closing.*
Chicago Telephone	118
Chicago Edison Light	143
Metropolitan Elevated preferred	72½
National Carbon common	86
National Carbon preferred	119
Union Traction common	—
Union Traction preferred	—

Metropolitan Elevated is showing considerable strength, advances having been made in both the common and preferred. It is now believed that dividends will be resumed after the first of the year or in the early spring.

It is stated that efforts to secure a dividend on the preferred stock of the Northwestern Elevated Railroad Company have been renewed by the stockholders, who a year ago petitioned the voting trustees for a disbursement. When the petition was presented to the trustees last year the petitioners were given to understand that the consolidation of the four elevated roads of Chicago was in a fair way of being worked out. It was understood at that time that within a year the deal would be completed under such an arrangement as would be beneficial to the holders of Northwestern preferred. The trustees of the Northwestern Elevated have agreed to give the request of the stockholders careful consideration.

ELECTRIC LIGHTING.

BASIN, WYO.—An electric light plant has been established at Basin.

COOPERSVILLE, MICH.—The village of Coopersville will install an electric light plant.

PENNSBURG, PA.—By a vote of 211 to 57, Pennsburg decided to increase its debt to $15,000 for the purpose of establishing a municipal electric light plant.

BERGEN, N. Y.—The village board has granted a franchise to the Genesee County Electric Light, Power and Gas Company, Batavia, N. Y., to construct and operate a plant in the village of Bergen.

FREELAND, PA.—The electric lighting contract has been awarded to the Freeland Consumers' Light Company. The contract is to run for three years, and lights are to be furnished at $60 each.

WILMINGTON, DEL.—The Commercial Light, Heat and Power Company, which recently obtained a franchise in this city, has turned over to the city treasurer $12,500 of the $50,000 which the company agreed to pay for public rights.

MINNEAPOLIS, MINN.—The Minneapolis General Electric Company will enlarge its plant. The company has purchased three lots on Main street, and will erect a three-story pressed-brick building to be used as a warehouse and stable.

ST. CATHARINES, ONTARIO—The city council has passed a by-law authorizing the agreement with the Lincoln Electric Light Power Company to continue the contract for eighty arc lights at $72.50 per light, which expired on November 1.

PEMBROKE, ONTARIO—By the new agreement between Pembroke and the Pembroke Electric Light Company, the company gets a franchise to erect poles and wires in the town for a period of thirty years, from January 1, 1907, and a further period if agreed upon.

SANFORD, N. C.—At a special meeting of the board of aldermen of the town of Sanford a franchise was granted the Buckhorn Power Company to enter the town. Under this franchise this company is to furnish lights by December 20 and power for manufacturing plants by July 1, 1907.

COLUMBUS, OHIO—The sinking fund trustees have accepted the $140,000 bond issue recently authorized by council for the municipal light plant. Ninety thousand dollars of the issue is to be expended for additional machinery, the remainder to be used for taking up defective bonds.

TOLONO, ILL.—The Tolono Ice, Light and Power Company has been formally organized. Officers for the balance of the year were elected as follows: H. W. Riley, president; Edward L. Brya, secretary and treasurer; A. L. Van Meter, manager; I. A. Manley, M. L. Van Meter, E. L. Brya, directors.

BLACKSBURG, VA.—The directors of the Blacksburg Power and Supply Company have placed an order with the Weber Gas Engine Company, of Kansas City, for the immediate installation of the machinery for the company's power and heating plant. The company expects to have the system in operation by January 1, 1907.

NEW IBERIA, LA.—W. P. Conery, representing the Bayou Teche Electric Light and Railway Company, of New Orleans, appeared before a special meeting of the city council recently with a proposition to buy the municipal electric light and waterworks plant. He agrees to assume the unpaid indebtedness of the plant, amounting to about $40,000.

MOBILE, ALA.—Mobile is considering the advisability of establishing a municipal lighting plant. The figures on which it bases its judgment in the matter are those obtained from Jacksonville, Fla. Jacksonville, nearly four years ago, obtained a lighting plant at a cost of $69,275, and by the end of the second year is said to have made the plant pay for itself in full.

TACOMA, WASH.—The city council has decided to ask bids for the installation of an electric plant to generate current for lighting the city. The city already owns its lighting system, but buys its current from the Seattle-Tacoma Power Company, whose contract expires in one year. Recently bids were asked for renewal of the contract and the proposals submitted were considered too high.

WINDSOR, ONTARIO—The finance committee of the council is in correspondence with the hydroelectric commission of the government in regard to bringing Niagara power to Windsor. Two schemes are being considered, one to secure just enough power to meet the demands of the city, the other to secure power for Windsor, Walkerville and Sandwich, making Windsor a distributing centre.

CENTERVILLE, MD.—At a special meeting the Centerville Light, Heat and Power Company was incorporated and the following officers were elected: W. J. Peall, president; Walter T. Wright, vice-president; J. Fletcher Rolph, secretary; Pere T. Forman, treasurer. The plant is to be operated day and night, and will not only furnish heat, light and power to the town, but will extend its lines into the country.

GEORGETOWN, WASH.—The Georgetown city council has issued permits to the Seattle Electric Company for the construction of power-plant buildings. When completed these will cover a ground space of 130,000 square feet and cost $1,000,000. The first of these buildings, which, with the machinery, is costing in excess of $500,000, is nearing completion. The buildings are to be wholly of reinforced concrete.

GREENVILLE, OHIO—The plant of the People's Electric Light, Heat and Power Company, which recently went into the hands of a receiver, has been sold for $15,000 to J. T. Blair, representing the second-mortgage bondholders. The original cost of the plant was $125,000. A committee, consisting of J. T. Blair, Frank Taylor and W. C. Pettit, has been appointed to look after the affairs of the company until a new board of directors can be elected.

RICHMOND, VA.—The council committee on light has declined the offer of the Virginia Passenger and Power Company to renew its contract for lighting the city for five years at $50 a light, and has entered into a contract with the company for one year from July 1, 1907, at $54.75 a light, with the privilege of renewing the contract for another year at the same rate. The company is to supply 800 arc lights of 1,200 candle-power each.

GREELEY, COL.—The Northern Colorado Power Company has purchased the Longmont, Loveland, Berthoud, Fort Collins and the Greeley power and electric light plants. The sale of the Greeley plant was closed in Denver by William Mayher, its manager for the last ten years. All the stockholders of the Greeley plant have sold their interests outright, with the exception of Mr. Mayher, who retains considerable stock, and is a director in the new company.

STOCKBRIDGE, MASS.—A Stockbridge lighting company has been organized, with Allen T. Treadway, president; Charles E. Hull, treasurer; Edward T. Hull, clerk. These officers, together with Daniel B. Fenn and Alexander Sedgwick, constitute the board of directors. All the capital stock has been subscribed for—$25,000 divided into 250 shares of $100 each. The system will be installed early in the spring, so that it may be in working order by the first of May.

AKRON, OHIO—To compete with local natural-gas companies, the Northern Ohio Traction and Light Company will make a reduction of fifty per cent for lighting, beginning January 1. The reduction will be from twelve to six cents per unit. The new rate with discount for prompt payment will mean a cut of sixty-seven per cent from the present rates. Additional machinery for lighting has been installed and the company will be prepared to supply almost the entire city. The same reduction is being made in Barberton.

ORANGE, N. J.—The Orange common council has passed resolutions awarding contracts for the municipal lighting plant to the Crocker-Wheeler Company and the Western Electric Company. The Crocker-Wheeler estimate totalled $33,047, and the concern will provide for that amount three Ball & Wood tandem-compound engines, three standard Crocker-Wheeler alternating-current generators, a switchboard complete and 350 arc lamps installed complete. The Western Electric Company, whose bid was $17,400, will furnish 1,200 shaved chestnut poles and approximately thirty miles of copper wire, covered.

ELECTRIC RAILWAYS.

INDEPENDENCE, KAN.—Work has been begun on the interurban electric railway to connect Independence, Chanute and Fort Scott.

TOLEDO, OHIO—The Toledo & Western Railway Company's property is to be sold at public auction at Sylvania, Ohio, December 5, at 12 o'clock noon.

NEWCASTLE, IND.—Contracts have been awarded for the power plant which the Indianapolis, Newcastle & Toledo Railway will erect west of Newcastle. The contract price is about $40,000.

BELLEVILLE, ILL.—An ordinance has been passed granting the Mascoutah & Belleville Electric Railway Company the right to construct and operate an electric line over certain streets in Belleville.

MUSKOGEE, I. T.—A movement is on foot for the building of an electric line between this city and Fort Smith, Ark. General Ira L. Reeves, who pushed to completion the street-car system in Muskogee, is at the head of the movement.

FLINT, MICH.—Franchises and rights of way have been secured for the extension of the Detroit, Flint & Saginaw electric line, from Frankemuth to this city. When this link is built electric cars can be run between Detroit and Bay City.

SPRINGFIELD, ILL.—The secretary of state has issued a license to incorporate to the Evansville, Mount Carmel & Northern Railway Company to construct a road from a point on the Cairo, Vincennes & Chicago Railroad, near Mount Carmel, Ill., to a point on the Wabash river between Illinois and Indiana.

OMAHA, NEB.—Omaha & Council Bluffs Street Railway Company will increase the capacity of its power-house in Omaha by the addition of $250,000 worth of machinery. The increase is made necessary by reason of additional car service and of the opening of two suburban lines finished recently by the company.

ATLANTA, GA.—The Georgia Securities Company, through its president, Clifford L. Anderson, and its secretary, Alfred Boylston, has filed its acceptance of the ordinance recently passed by council granting certain franchises for the use of a number of the city's streets in the construction of the Atlanta, Griffin & Macon electric railway.

MARYSVILLE, OHIO—The Magnetic Springs & Northern Electric Railroad, which is now being constructed from the former place to Richwood, La Rue and Kenton, has been granted a franchise by the county commissioners to operate the road along the county pikes 700 feet this side of Richwood and 200 feet on the north side of Richwood.

ATLANTA, GA.—S. S. Busch, Atilla Cox, Jr., and other Louisville capitalists, have purchased from J. L. Bass the entire street-railway and lighting system at Rome, Ga., at $300,000. Of this amount the franchise is valued at $40,000. The actual consideration is said to have been $175,000, the balance of the purchase money to be spent in improvements.

ATLANTA, GA.—The Georgia Railway and Electric Company is planning extensive additions to equipment, in order to relieve the congestion in street-car traffic, which has for some time seriously impaired the service. About twenty-five new cars will be added to the equipment this winter, of which nine will be of the semi-convertible type, with double trucks.

CHAMBERSBURG, PA.—A movement is on foot at Hancock to build a trolley line from McConnellsburg, Pa., *via* Hancock, to Berkeley Springs, W. Va., twenty-eight miles, passing through three states in that distance. McConnellsburg is in the midst of a rich farming country, thickly populated. The town is the county seat of Fulton county. A number of capitalists are said to be interested in the project.

ANNAPOLIS, MD.—At a meeting of the stockholders of the Washington, Baltimore & Annapolis Electric Railway the capital stock of the company was increased from $4,000,000 to $5,250,000. The increase will be through the issue of 25,000 additional shares of capital stock of the par value of $50 each. This company is building the new line from Baltimore to Washington, and owns a branch to Annapolis.

LINCOLN, NEB.—The stockholders of the Citizens' Railway Company have voted to double the capital stock of the corporation and will begin the construction of several new lines at once. One of these lines will be built to the southern limits of the city, tapping one of the best-paying territories of the traction company. The present capital stock is $100,000, and under the new arrangement will be $200,000. Much of this has already been subscribed.

ATLANTA, GA.—At a meeting of the common council of Hapeville, a franchise to lay tracks and operate electric cars within the limits of the town was granted to the Georgia Railway and Electric Company. Work on the road will start within a month and it is expected that cars will be running by the middle of March. The company, however, has been allowed one year to get the road in operation. The road will run to East Point, where it will connect with the main line.

COLUMBUS, OHIO—Philip R. Peters, Edward Delancy, McClellan Matens, Louis J. Snyder and Philip Rising have incorporated the Lancaster Traction and Power Company, of Lancaster, Fairfield county, Ohio, with a capital stock of $400,000, of which $200,000 is six per cent non-cumulative preferred. The new company will take over the existing street railway, lighting and power plants in Lancaster, and also the traction lines running from Lancaster to the Boys' Industrial School. Interested in the companies are R. E. Sheldon and E. K. Stewart, of the Columbus Railway and Light Company, and Cincinnati and Philadelphia men.

NEW YORK, N. Y.—At a meeting of the board of supervisors of Nassau county a franchise was granted to the Huntington Railroad Company to build its electric line over that section of the proposed route in the town of Oyster Bay from the Suffolk county line in Farmingdale southwardly to the Suffolk county line. The franchise was granted for a term of fifty years, free of cost, with a privilege of renewal for fifty years more at the expiration of the above-named period, at the rate of $5 per year for every 100 feet of track, with an increase every twenty-five years thereafter. Work is to be commenced within one year, the road to be completed and in operation within three years.

MILWAUKEE, WIS.—The Milwaukee & Fox River Valley Electric Road is the name of a proposed line incorporated by J. M. Seaman, of Sheboygan, and which, it is said, will connect with the Milwaukee Northern electric line at Cedarburg, extending from that point north to Fond du Lac. Mr. Seaman's plans are for a line to Plymouth, Elkhart Lake, Stockbridge and along the east side of Lake Winnebago. The Milwaukee Northern line will run alongside the right of way of the Northwestern road to points many miles distant from the other route to Fond du Lac. Reports from Sheboygan are that the new road will have a right of way over the double track of the Milwaukee Northern into Milwaukee.

SALT LAKE CITY, UTAH—The board of county commissioners has granted franchises to Salt Lake's two electric railway companies for interurban lines running between Salt Lake City, Bingham, Garfield, Sandy, Halliday and Bingham Junction. One franchise was granted to Harry P. Clark for an interurban electric railroad between Salt Lake City, Bingham, Garfield and Bingham Junction. The other was granted the Utah Light and Railway Company for a line between Salt Lake City, Sandy, Halliday, Garfield and Bingham Junction. The franchises granted give the two companies the right to construct and maintain the roads, to haul freight, express, passengers, baggage, United States mail and all other materials between any and all stations on the lines.

MOUNT VERNON, N. Y.—The New York, Westchester & Boston Railroad Company, which for months has been pushing the construction work on its proposed four-track electric road from 177th street in the Bronx to the Port Chester and Connecticut line, has practically stopped work in the upper part of the Bronx and in this city. This, it is explained, is due to the fact that the company has thus far failed to obtain a considerable portion of its right of way both in the Bronx and in Westchester county east of Mount Vernon. In Pelham Manor the company has been enjoined by the courts, and in New Rochelle the aldermen have refused to grant a franchise. It is said that the company will stop entirely unless the desired rights are obtained very soon. It is reported that negotiations looking to the purchase of the Port Chester road by a competing line which holds franchises through all the towns in Westchester county to Port Chester are now in progress.

TELEPHONE AND TELEGRAPH.

KEOKUK, IOWA—The Mississippi Valley Telephone Company will erect a new office building.

MASON CITY, IOWA—The Western Electric Telephone Company will install a central-energy system.

WAHPETON, N. D.—The Northwestern Telephone Exchange Company has let the contract for an exchange at Wahpeton.

JEFFERSON, GA.—Workmen are erecting a telegraph line along the right of way of the Gainesville-Midland Railroad, between Jefferson and Athens.

BURLINGTON, IOWA—The Gate Telephone Company has been incorporated with $10,000 capital. It is affiliated with the Mississippi Valley Telephone Company.

BETHPAGE, TENN.—The citizens of Westmoreland have organized a local telephone company. Westmoreland is twenty miles from Gallatin on the Scottsville branch of the Louisville & Nashville Railroad.

DETROIT, MICH.—The Michigan State Telephone Company has sold $1,250,000 six per cent three-year debenture bonds to N. W. Harris & Company, of New York city. The proceeds are to pay for new construction.

WARRENSBURG, N. Y.—The Chestertown Telephone Company is constructing a line from Horicon to Hague *via* Graphite, When completed, direct communication will be established with Lake Champlain points.

ANNAPOLIS, MD.—The Chesapeake & Potomac Telephone Company, it is said, proposes to submit to the council an ordinance asking the use of certain city streets in Annapolis for the laying of conduits. This will eventually mean the placing of all wires underground.

BROOKLYN, N. Y.—Work on a new wireless telegraph station in the Brooklyn navy yard has been started. The new building will be of brick and will cost about $8,000. It will be equipped with two masts and will be about five times the size of the station now being used.

BIRMINGHAM, ALA.—The Southern Bell Telephone and Telegraph Company is putting in telephone exchanges at Cordova and Carbon Hill in Walker County. The People's Telephone Company is putting in an exchange at Oakman, in the same county, which service will be extended to several mines in that section.

WINDSOR, ONTARIO—The city council has accepted a proposition made by the Bell Telephone Company for a renewal of its franchise in Windsor for a term of five years, the company to place its wires in conduits on certain streets, remove its poles from Goyeau street, give the city six free telephones and pay $750 per year for the five years.

PITTSFIELD, MASS.—Pittsfield and Springfield are to have an extra toll line early next season at an estimated cost of $40,000. There are now four direct toll lines and three auxiliary lines, which the growing business of Pittsfield finds insufficient. The proposed line will run through West Springfield, the north end of Westfield, Montgomery, Chester Center, Middlefield, Hinsdale, Dalton to Pittsfield.

TROY, N. Y.—The New York & Vermont Home Telephone Company, of Troy, has been incorporated with the secretary of the state, with a capital stock of $100,000, to operate telephone lines in Rensselaer, Washington, Saratoga, Warren and Essex counties. The company will be similarly incorporated in Vermont. The directors are: W. Levis Burk, William C. Colburn, James H. Caldwell, Irvings S. Freeman and William Connors, of Troy; William L. Hitchcock, of Cambridge, and Clarence E. Parker, H. J. Stevens, Floyd E. Cole, of Granville.

DATES AHEAD.

American Society of Mechanical Engineers. New York city, December 4-7.

Electrical Trades Exposition. Chicago, Ill., January 14-26, 1907.

Jamestown Ter-Centennial Exposition. Norfolk, Va., April 26 to November 30, 1907.

Northwestern Electrical Association. Milwaukee, Wis., January 16, 1907.

INDUSTRIAL ITEMS.

THE AITON MACHINE COMPANY, Harrison, N. J., in bulletin No. 3 illustrates a new armoring machine.

QUEEN & COMPANY, INCORPORATED, Philadelphia, Pa., have published a small catalogue devoted to portable test sets for all uses.

THE CENTURY ELECTRIC COMPANY, St. Louis, Mo., has ready for distribution bulletin No. 7, describing and illustrating single-phase, alternating-current motors.

THE TRAY PLATE BATTERY COMPANY, Binghamton, N. Y., it is rumored, will soon occupy a new factory and will have greatly increased facilities.

THE S. H. COUCH COMPANY, Boston, Mass., has removed its offices to 156 Purchase street. The company has been growing constantly and this change is necessary to meet the demand for more commodious quarters.

THE PHOENIX GLASS COMPANY, New York city, is mailing a unique Thanksgiving reminder to its patrons. The company states that its inner-globe proposition is a cause for thanksgiving to all who accept it.

THE ALLIS-CHALMERS COMPANY, Milwaukee, Wis., has published bulletin No. 1417, describing smelting furnaces and accessory equipment. This apparatus is made by the mining machinery department.

THE ROCKWELL ENGINEERING COMPANY, New York city, has ready for distribution a series of literature devoted to fuel oil and burning appliances, welding furnaces, rivet-heating furnaces, brazing furnaces and metal-melting furnaces.

THE JEFFREY MANUFACTURING COMPANY, Columbus, Ohio, in catalogue No. 1 describes and illustrates crushing and pulverizing machinery. Among the applications illustrated there are several installations of electrically driven pulverizers.

THE NERNST LAMP COMPANY, Pittsburg, Pa., has published a handsome booklet devoted to the new Pennsylvania terminal in New York city. The booklet is a short study of the lighting of this terminal.

THE WESTINGHOUSE TRACTION BRAKE COMPANY, Pittsburg, Pa., has ready for distribution a bulletin descriptive of the direct-current unit, T-2001. The text describes the Westinghouse straight air-brake equipment, schedule SM.

THE H. T. PAISTE COMPANY, Philadelphia, Pa., will be pleased to send its November catalogue to any one interested upon request. This bulletin is devoted to a description of panel boxes. In addition to the descriptive matter, which is highly interesting, the physical appearance of this bulletin is considerably above the average in attractiveness.

THE A. D. GRANGER COMPANY, 95-97 Liberty street, New York city, has published a handsome catalogue descriptive of "Star Safety" water-tube boilers. In addition to a careful description of the boiler there are several illustrations of the details of the boiler and reproductions of views of a number of buildings where these boilers have been installed.

THE CLEVELAND GAS AND ELECTRIC FIXTURE COMPANY, Cleveland, Ohio, has put on the market an innovation in the fixture trade, which it calls its "C" box line fixtures. These goods are boxed in a small package, which is convenient for carrying in stock on shelves, and they are being received with great favor by the trade. The company is building a new factory at Conneaut, Ohio, with double the floor space of its present factory at Cleveland. Part of this equipment is already in operation.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., announces that in addition to the two alternating-current generators now in operation at the Kingsland repair shops of the Delaware, Lackawanna & Western Railroad there is to be installed an additional alternating-current, engine-type generator of 300 kilowatts, 480 volts, 225 revolutions per minute, three-phase, sixty cycles, to furnish the increased demand for power. The other two alternating-current machines have been working a little over a year.

THE BLAKE SIGNAL AND MANUFACTURING COMPANY, 246 Summer street, Boston, Mass., announces that the "Climax" solder-

ing flux tube, which was formerly put up by the Climax Manufacturing Company, Boston, Mass., has been taken over and all patents, rights, good will, etc., as far as the soldering flux tube is concerned, are owned by the Blake company. The tube will be put out in connection with the other Blake patents, such as the Blake tube flux. The Blake company announces that it has improved the quality of the tube and is prepared to fill all orders promptly.

THE STEEL CITY ELECTRIC COMPANY, Pittsburg, Pa., has appointed V. C. Gilpin, 120 Liberty street, New York city, its New York representative to succeed W. J. Bramhall. Mr. Gilpin will have charge of sales in the New York district and vicinity, and will have on hand also a large stock of goods for the purpose of making quick deliveries. The Steel City Electric Company manufactures Fullman lock nuts, Fullman patent floor outlet boxes and other electrical and mechanical specialties.

M. W. DUNTON & COMPANY, 65 Atlantic avenue, Providence, R. I., announce that a recent inventory of stock on hand showed 7,244 pounds of regular sizes of braided cotton sleevings for insulating purposes, in addition to a large quantity of special sleevings which are constantly being made up for large manufacturers. When one stops to think that it requires from 300 to 1,500 feet, according to size, to make a single pound, the enormous quantity carried by this firm will be appreciated.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., has issued a booklet of twenty-eight pages entitled "Holiday Suggestions." The cover design is in three colors and is appropriate, suggesting as it does the holiday season. The first few pages are devoted to electric reading and desk lamps, many handsome designs being shown, and the next two pages to electric heating devices, the electric chafing-dish and flat-iron being given prominence. Considerable space is devoted to miniature street railways, motors, engines and motor boats. There is also descriptive matter concerning learner's telegraph outfits, flashlights, electric clocks and many other electrical novelties. Copies of this publication may be had upon request.

THE NEW YORK ELECTRIC CONTROLLER COMPANY, 21-27 New Chambers street, New York city, manufacturer of automatic electric controlling devices, reports a steadily growing demand for and great success with its apparatus. The devices which the company makes a specialty of were developed and put in use two years ago, and they were so successful in operation that the company is now receiving reorders from the same customers. The elevator controller works on any kind of a motor-driven elevator and is said to be absolutely safe and sure in its action. The controllers permit the stopping and starting of the motors from any number of points by means of any ordinary snap-switch carrying one-tenth ampere of current. This means a saving in current consumption, as the motor is so easily started and stopped that the employés do not keep it running when not actually needed, and electrical troubles due to use of hand rheostat and switch are eliminated. The wiring is simple and inexpensive.

THE NATIONAL BRAKE AND ELECTRIC COMPANY, Milwaukee, Wis., announces among recent orders for air-brake equipments the following, many of which are repeat orders: Chicago Union Traction Company, Chicago, Ill., 120 equipments; United Railroads of San Francisco, San Francisco, Cal., 110 equipments; Seattle Electric Company, Seattle, Wash., thirty-eight equipments, fourteen trailers; Norfolk & Portsmouth Traction Company, Norfolk, Va., thirty-three equipments, eight trailers; Chattanooga Railway Company, Chattanooga, Tenn., twenty-seven equipments; Northern Ohio Traction Company, Akron, Ohio, twenty equipments; Washington Water Power Company, Spokane, Wash., sixteen equipments, five trailers; Rhode Island Company, Providence, R. I., fourteen equipments; Public Service Corporation, Camden, N. J., thirteen equipments; Oakland Traction Construction Company, Oakland, Cal., ten equipments; Georgia Railway and Electric Company, Atlanta, Ga., ten equipments; St. Louis Car Company, for Tampa & Sulphur Springs Railway, Tampa, Fla., eight equipments; Illinois Steel Company, South Chicago, Ill., eight equipments; Union Street Railway Company, New Bedford, Mass., six equipments; Central Pennsylvania Traction Company, Harrisburg, Pa., six equipments; Augusta-Aiken Railway and Electric Company, Augusta, Ga., four equipments; R. W. Blackwell & Company, Ltd. (foreign), six equipments; Knoxville Railway and Light Company, Knoxville, Tenn., three equipments; Spokane Traction Company, Spokane, Wash., three equipments; Lookout Mountain Railway Company, Lookout Mountain, Tenn., two equipments; McGuire-Cummings Company (car builders), Chicago, Ill., two equipments; Butte Electric Railway Company, Butte, Mont., two equipments; Illinois Traction System, Danville, Ill., one equipment; Johnstown Passenger Railway Company, Johnstown, Pa., one equipment; International Railway Company, Buffalo, N. Y., one equipment; Duluth Street Railway Company, Duluth, Minn., one equipment; Indiana, Columbus & Eastern Traction Company, Newark, Ohio, one equipment; Everett Railway, Light and Power Company, Everett, Wash., six equipments. In addition the company has received orders for over 800 of the new type N oil-pneumatic governors and 400 emergency valves since the close of the recent Columbus street-railway convention.

NEW MANUFACTURING COMPANIES.

ALBANY, N. Y.—The K. W. Electrical Engineering Company, of Buffalo, has been incorporated with a capital of $15,000. The directors are: L. W. Whipperman, G. E. Morgan and E. W. McIntyre, of Buffalo.

ATLANTA, GA.—W. E. Carter, E. D. Kennedy, F. A. Hoyt and F. P. Provost have incorporated the W. E. Carter Electric Company with a capital of $5,000. Its purpose is to manufacture and sell gas and electric supplies.

DAVID CITY, NEB.—An electric supply company has been organized in David City with a capital of $50,000, with Edward Butler as president; M. L. Lane, vice-president, and J. R. Evans, secretary and treasurer.

Record of Electrical Patents.

Week of November 20.

836,088. LETTER FOR ELECTRIC SIGNS. Horace B. Camp, Akron, Ohio. Filed July 3, 1905. A sign with recesses for incandescent lamps.

836,093. IGNITION DEVICE FOR EXPLOSION ENGINES. Adolphe Clément, Levallois-Perret, France. Filed October 2, 1902. An igniter for multi-cylinder engines.

836,107. SECONDARY BATTERY. Louis H. Flanders, Wilkinsburg, Pa., assignor to the Westinghouse Machine Company. Filed April 15, 1905. The electrodes are encircled by an insulating member.

836,122. HIGH-POTENTIAL INSULATOR. Fred M. Locke, Victor, N. Y. Filed March 23, 1903. The supporting member is provided with a tapering hole for receiving the tapering holding bolt.

836,153. SIGNALING SYSTEM FOR ELECTRIC RAILWAYS. Louis H. Thullen, Edgewood Park, Pa., assignor to the Union Switch and Signal Company, Swissvale, Pa. Filed June 9, 1906. A block-signaling system for alternating-current railways.

836,155. ELECTRICAL CONDUCTOR AND JOINT THEREFOR. Frank J. Tone, Niagara Falls, N. Y. Filed November 11, 1905. A layer of graphite is interposed between the surfaces of the joint.

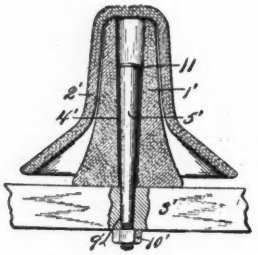
836,177. ART OF PRODUCING PIGMENTS BY ELECTROLYSIS. Edwin D. Chaplin, Boston, Mass. Filed February 3, 1906. Consists in electrolyzing a soluble acid salt of lead.

836,202. TELEPHONE-RECEIVER SWITCH. James McMahon, Oakdale, Cal. Filed July 24, 1905. A switch within the receiver controlled by a projecting lever.

836,204. TELEPHONE SYSTEM. Frederick R. Parker, La Fayette, Ind. Filed July 27, 1903. A modified central energy system.

836,243. ELECTRICALLY OPERATED RAILWAY SIGNAL AND GATE. James G. O. Combs and Isaac D. Combs, Harold, Mo. Filed April 20, 1906. The gate and signals are operated by electric motors.

836,261. MANUFACTURING ELECTRODES FOR ELECTRICAL ACCUMULATORS BY MEANS OF CONTINUALLY WORKING MACHINES. Ernst W. Jungner, Kneippbaden, Sweden, assignor to Nya Ackumulator-Aktiebolaget Jungner, Stockholm, a company. Filed September 11, 1905. Two metallic ribbons fed continuously toward each other are perforated and then receive an interposed layer of acting material.



836,122.—HIGH-POTENTIAL INSULATOR.

836,279. MEANS FOR CONTROLLING THE SUPPLY OF ELECTRIC CURRENTS. Friedrich W. Schneider, Frankfort-on-the-Main-Bockenheim, Germany, assignor to the firm of Voigt and Haeffner Aktiengessellschaft, Frankfort-on-the-Main-Bockenheim, Germany. Filed December 17, 1903. A regulator of the make-and-break type controlled by a "hot-wire."

836,280. SWITCH FOR ELECTRIC CIRCUITS. Burton G. Seavey and Walter G. Millen, Keene, N. H. Filed September 22, 1905. Terminal blocks with bridging members for making several connections.

836,282. ELECTRIC HEATING PAD. Luella W. Shellhamer, Los Angeles, Cal. Filed April 2, 1906. An insulated wire resistance surrounded by a flexible body.

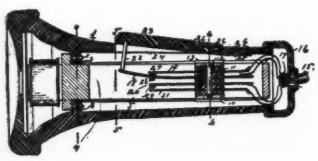
836,295. DEVICE FOR LIGHTING BY ELECTRICITY REVERSED GAS BURNERS. Paul Benard, Epernay, France. Filed November 21, 1905. An igniter for inverted gas mantles.

836,298. PROCESS OF MAKING GLASS INSULATORS OR OTHER GLASS ARTICLES. Henry M. Brookfield, New York, N. Y. Filed April 22, 1903. The molten glass is automatically divided into measured masses which are delivered to the molds.

836,307. CIRCUIT-CONTROLLING KEYBOARD APPARATUS. Patrick B. Delany, South Orange, N. J. Filed March 29, 1904. A controller for machine telegraphy.

836,314. CHARGING SYSTEM FOR STORAGE CELLS OR BATTERIES. Jacob De S. Freund, Edgewood Park, Pa., assignor to the Union Switch and Signal Company, Swissvale, Pa. Filed June 10, 1905. A system charging signaling batteries from a central source.

836,339. MAGNETIZABLE BODY FOR THE MAGNETIC RECORD OF SPEECH, ETC. Peder O. Pederson, Copenhagen, Denmark, assignor to American Telegraphone Company. Filed June 21, 1901. A blank for telegraphone records, coated electrolytically.



836,202.—TELEPHONE RECEIVER SWITCH.

836,352. SWITCH BOX. Charles E. Youmans, Yonkers, N. Y., assignor to Julia Hall Youmans, Yonkers, N. Y. Filed June 13, 1904. A water-tight switch box.

836,355. PRODUCTION OF GRAPHITE. Edward G. Acheson, Stamford Township, Ontario, Canada. Filed September 22, 1906. A method of making soft, unctuous and non-coalescing graphite by heating carbonaceous and carbide-forming materials.

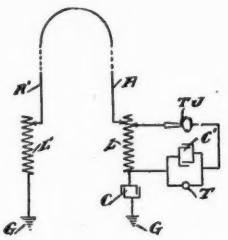
836,396. ELECTRIC OUTLET INSULATOR. John E. Moore, Davenport, Iowa. Filed October 27, 1902. A combination fixture for gas and electric outlets.

836,407. TELEPHONE ATTACHMENT. Joseph Silverman, San Francisco, Cal. Filed March 5, 1906. A spring attachment to the telephone hook for holding it in two positions.

836,427. MOTOR-STARTING SWITCH. Thorsten von Zweigbergk, Preston, England. Filed May 21, 1906. Two terminals are provided, one for determining the starting resistance and one for short-circuiting it.

836,454. TELEGRAPH KEY. Edward M. McConihay, Lewiston, W. Va. Filed December 29, 1905. A modified key.

836,480. DRY-BATTERY CELL. John W. Brown, Cleveland, Ohio, assignor to National Carbon Company, Cleveland, Ohio. Filed September 14, 1906. A battery in which the internal resistance is the same along any path.



836,531.—MEANS FOR RECEIVING INTELLIGENCE COMMUNICATED BY ELECTRIC WAVES.

836,489. TESTING SYSTEM FOR TELEPHONE LINES. William W. Dean, Chicago, Ill., assignor to Kellogg Switchboard & Supply Company, Chicago, Ill. Filed June 29, 1903. A testing device is normally connected with the tipstrand of the operator's cord.

836,490. DETACHABLE INCANDESCENT LAMP SHADE. Henry D'Olier, Jr., Philadelphia, Pa. Filed September 21, 1905. The shade is held to the end of the socket by clips.

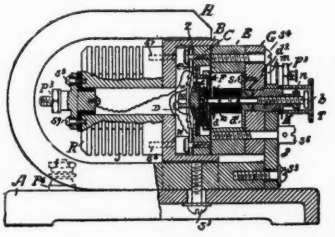
836,497. PROCESS OF IMPROVING THE MAGNETIC QUALITIES OF IRON-SILICON-ALUMINUM ALLOYS. Robert A. Hadfield, Sheffield, England. Filed August 21, 1906. The process consists in reducing the hysteresis action of an iron-silicon-aluminum alloy, low in carbon and manganese, by heating above the critical point and then cooling.

836,512. METHOD OF EXTRACTING GUTTA-PERCHA. Eulalie C. Larsen, Singapore, India, administratrix of Aime Arnaud, deceased. Filed August 23, 1905. A process for extracting gutta-percha from leaves.

836,514. TELEPHONE CORD-CIRCUIT. Albion D. T. Libby, Chicago, Ill., assignor to Kellogg Switchboard and Supply Company, Chicago, Ill. Filed September 3, 1904. A cord for a magneto system.

836,531. MEANS FOR RECEIVING INTELLIGENCE COMMUNICATED BY ELECTRIC WAVES. Greenleaf W. Pickard, Amesbury, Mass. Filed August 30, 1906. The receiver is formed of silicon.

836,581. MEANS FOR ELIMINATING OR REDUCING THE INFLUENCE OR DISTURBING CURRENTS ON TELEPHONE CIRCUITS. Charles M. Jacobs, Reading, England. Filed January 27, 1906. The receiver circuit is provided with a phonopore-winding.



836,611.—REGULATING DEVICE FOR TELEPHONE RELAYS AND TRANSMITTERS.

836,611. REGULATING DEVICE FOR TELEPHONE RELAYS AND TRANSMITTERS. Herbert E. Shreeve, Newton, Mass., assignor to American Telephone and Telegraph Company. Filed October 26, 1905. A thermal resistance is provided for regulating a variable-resistance telephone.

836,612. REGULATING DEVICE FOR TELEPHONE RELAYS AND TRANSMITTERS. Herbert E. Shreeve, Newton, Mass., assignor to American Telephone and Telegraph Company. Filed October 26, 1905. A finely divided variable-resistance material, the pressure on which is controlled electromagnetically.

836,639. CONTACT WHEEL. Edward L. Dunn, Washington, D. C., assignor of one-third to Jacob Gerke, Ballston, Va. Filed February 21, 1906. A ball-bearing trolley wheel.